John Marston

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SYSTEMATICALLY ARRANGED

BY

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GLOSSARY.

Ægypten, Egypt.
Aleuten, Aleutian Islands.
Algerien, Algeria.
Amazonenstrom, Amazon River.
Anden Gebirge, the Andes.
Arabien, Arabia.
Aral S., Lake Aral.
Asien, Asia.
Atlantischer Ocean, Atlantic Ocean.
Australien, Australia.
Azorische In., the Azores.
Bahama In., Bahama Islands.
Baumwolle, Cotton.
Bonin In., Bonin Islands.
Brasilien, Brazil.
Californien, California.
Canarische In., Canary Islands.
Cap der guten Hoffnung, Cape of Good Hope.
Cap Horn, Cape Horn.
Cap Verdische In., Cape Verde Islands.
Caraibisches M., Caribbean Sea.
Carolinen In., Caroline Islands.
Caspisches M., Caspian Sea.
Chinawälder, Bathbark forests.
Deutschland, Germany.
Falklands In., Falkland Islands.
Feuerland, Terra del Fuego.
Frankreich, France.
Freundschafts In., Friendly Islands.
Gallopagos In., Gallopagos Islands.
Gerste u. Hafer, barley and oats.
Gewürznelken, cloves.
Grönland, Greenland.
Grossbritannien, Great Britain.
Grosser oder Stiller Ocean, Pacific Ocean.
Habesch, Habesh.
Himmalya Geb., Himmalaya Mountains.
I. Island, Iceland.
I. Karafta oder Sachalin, Island of Karafta or Sachalin.

GLOSSARY—(*Continued.*)

Indisches Meer, Indian Ocean.
Irland, Ireland.
Kaffee, coffee.
Kaschmir, Cashmere.
Kurilen, Kurile Islands.
Ladronen In., Marian Islands.
Mais, Indian corn.
Malediven In., Maldive Islands.
Mandschurei, Manchooria.
Marañon od. Amazonenstrom, Amazon River.
Marianen od. Ladronen In., Marian Islands.
Mb. v. Mexico, Gulf of Mexico.
Mendana's Arch., Mendana's Archipelago.
Mittel Amer, Central America.
Mittelländisches Meer, Mediterranean Sea.
Mongolei, Mongolia.
Moskau, Moscow.
Muscatbaum, nutmeg tree.
N. Gran., New Grenada.
Neufundland, Newfoundland.
Neu Guinea, New Guinea.
Neu Seeland, New Zealand.
Nord Amerika, North America.
Norwegen, Norway.
Nubien, Nubia.
Ost Indien, East India.
Patagonien, Patagonia.
Pfeffer, pepper.
Reis, rice.
Roggen, rye.
Russisches Amerika, Russian America.
Russland, Russia.
Sandwichs In., Sandwich Islands.
Schiffer In., Navigators' Islands.
Schwarzes M., Black Sea.
Schweden, Sweden.
Sibirien, Siberia.
Sklaven S., Slave Lake.
Spanien, Spain.
Süd Amerika, South America.
Thee, tea.
Toisen, toises, (1t.=6 feet.)
Türkei, Turkey.
Vanille, vanilla.
Vereinigte Staaten, United States.
Vulc. v. Aconcagua, Volcano of Aconcagua.
Weitzen, wheat.
West Indien, West Indies.
Wüste Sahara, Desert of Sahara.
Wüste Schamo oder Gobi, Desert of Shamo or Gobi.
Zeichenerklärung für fig. 1, 2, *u.* 3, Explanation of the marks in figs. 1, 2, and 3.
Zimmt, cinnamon.
Zucker, sugar.

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Aleuten In., Aleutian Islands.
Amazonenstrom, Amazon River.
Arabien, Arabia.
Arabisches M., Arabian Sea.
Asien, Asia.
Atlantischer Ocean, Atlantic Ocean.

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Behringsstrasse, Behring's Straits.
Baffins Meer, Baffin's Bay.
Californien, California.
Canarische In., Canary Islands.
Cap der guten Hoffnung, Cape of Good Hope.
Capstadt, Capetown.
Cap Verds In., Cape Verde Islands.
Caspisches Meer, Caspian Sea.
Donau, Danube.
Felsen Geb., Rocky Mountains.
Fensterschwalben, Domestic swallows.
Feuerland, Terra del Fuego.
Freundschafts In., Friendly Islands.
Gesellschafts In., Society Islands.
Gr. Bären See, Great Bear Lake.
Grönland, Greenland.
Grossbritannien, Great Britain.
Grosser Ocean, Pacific.
Häringe, Herrings.
Hudsons Meer, Hudson's Bay.
I. Melville, Melville Island.
Indisches Meer, Indian Ocean.
Lissabon, Lisbon.
Makrelen, Mackerel.
Meerb. v. Bengalen, Bay of Bengal.
Meerb. v. Mexico, Bay of Mexico
Mongolei, Mongolia.
Neuseeland, New Zealand.
Neu Sibirien, New Siberia.
Nord Amerika, North America.
Nördliches Eismeer, Arctic Sea.
Patagonien, Patagonia.
Raben u. Kräken, Ravens and crows.
Rauchschwalben, Barn swallows.
Russisch Amerika, Russian America.
Schiffer In., Navigators' Islands.
Schleiereulen, Barn owls.
Schwarzes Meer, Black Sea.
Sibirien, Siberia.
Sklavensee, Slave Lake.
Staare u. Amseln, Starlings and blackbirds.
Süd Amerika, South America.
Uferschwalben, Bank swallows.
Vereinigte Staaten, United States.
Versammlungs- u. Abzugspunkt, Place of meeting and departure.
Wachteln, Quails.
Warschau, Warsaw.
West Indien, West Indies.
Wien, Vienna.
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GLOSSARY.

I. *Kaukasische oder Weisse Race*, Caucasian or White Race.
II. *Mongolische oder Gelbe Race*, Mongolian or Yellow Race.
III. *Æthiopische oder Schwarze Race*, Ethiopian or Black Race.
IV. *Amerikanische oder Kupferfarbige Race*, American or Copper-colored Race.
V. *Malayische oder Olivenfarbige Race*, Malay or Olive-colored Race.
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Afghanen, Afghans.
Algonkiren, Algonkins.
Araber, Arabs.
Azteken, Azteks.
Berbern, Berbers.
Birmanen, Birmans.
Bucharen, Bucharians.
Caffern, Caffres.
Californier, Californians.
Canadier, Canadians.
Caraiben, Caribbeans.
Celten, Celts.
Chaldäer, Chaldæans.
Chinesen, Chinese.
Cinbebassen, Cinbebasses.
Colombier, Colombians.
Eleuten, Aleutians.
Eskimos, Esquimaux.
Ethiopier, Ethiopians.
Fellatas, Fellatah.
Finnen, Finns.
Germanen, Germans.
Gothen, Goths.

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GLOSSARY—(*Continued*).

Hindus, Hindoos.
Hottentotten, Hottentots.
Iberier, Iberians.
Jakuten, Yacoots.
Japanesen, Japanese.
Jukaghiren, Youkaghirs.
Kalmücken, Calmucks.
Kamtschadalen, Kamskadales.
Kaukasier, Caucasians.
Kirghisen, Kirghese.
Koriälen, Koreans.
Kosaken, Cossacks.
Kriks, Creek Indians.
Lappen, Laplanders.
Letten, Lethonians.
Madagassen, Madagassees.
Mandschus, Manchoos.
Mauren, Moors.
Mongolen, Mongols.
Neger, Negroes.
Negritos, Negritoes.
Neuseeländer, New Zealanders.
Osagen, Osages.
Osmanen, Osmanli.
Ostiaken, Ostiaks.
Patagonen, Patagonians.
Pelasger, Pelasgians.
Perser, Persians.
Samojeden, Samoeids.
Sius, Sioux Indians.
Slaven, Slavonians.
Soyten, Soyetes.
Tibetaner, Thibetans.
Tschucktschen, Tchoukches.
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Wogulen, Voguls.

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BOTANY.

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Introduction.

Botany makes us acquainted with plants, or the vegetable kingdom. Plants are organized productions of nature, possessing neither sensation nor voluntary motion.

The vital actions of the plant have for their object, solely, the nourishment of the individual and the continuation of the species. In animals, on the other hand, life is exhibited in a more complicated manner: since we not only find actions occur which are directed to same special purpose, or produced by some inward impulse, but the faculty of sensation here presents itself for the first time; that is, the power of bringing home to consciousness by means of the senses, the impressions of the external world. Hence we term the animal *animate*, the plant *inanimate;* and for the same reason the functions of nutrition and reproduction possessed by both plants and animals are said to be expressions of the *vegetable*, while those of sensation and voluntary motion peculiar to the animal, belong to the *animal* life.

The motions of the so-called sensitive plants, as the clover (*Hedysarum gyrans*), venus Fly-trap (*Dionæa musipula*), various mimosas (*Mimosa pudica, sensitiva,* and others), are not spontaneous or innate, but rather dependent on external influences, or else are the result of purely mechanical operations, as exemplified in the bursting of seed capsules. Even if in the above-mentioned movements of plants, as well as in the sleep of plants and similar phenomena, it be impossible to deny a certain sensibility to light, air, cold, heat, &c., yet we need never confound such manifestations of vitality with the conscious perceptions of the animal.

Striking as is the difference between a plant and an animal, as seen in the higher organizations of both kingdoms, yet individual cases do occur in which the line of distinction is very difficult to draw; where the entire structure is so simple, that the same object has been referred now to one kingdom, and now to another. It must also be noted, that this difficulty of separation lies not between the highest plant and the lowest animal, but between the lowest of these; the distinctions and distance widening between the two as we ascend in the scale of structure.

Essentials to the Existence of Plants.

Plants in general require for their existence: 1, *a soil* into which they may root, and from which they may derive certain materials necessary to

their growth; 2, *water*, through which, as a dissolving medium, all the substances derived from the soil are introduced into the plant; 3, *atmospheric air*, from which the plant absorbs carbonic acid by day, fixing its carbon, and exhaling the oxygen; 4, *light*, which facilitates the reception of nutriment, operates in respiration and in the coloration of the different parts of the plant, and in part causes the sleep of plants; 5, *heat*, co-operating with light in the last result, and in causing the inhibition of liquid food, and likewise influencing germination and the periodical growth of plants. Electricity has long been known as influencing the growth of plants, but the precise nature and extent of its action are not satisfactorily established, although numerous experiments have been made on the subject.

I. ELEMENTARY ORGANS OF PLANTS.

1. Cellular Tissue.

Cellular Tissue is the elementary material found in all plants, and in all parts of the plant. As the name indicates, it is composed of an aggregation of cells of different shapes. The single cell, when isolated, is spherical or spheroidal, the shape, however, varying considerably when aggregated. Some special names for differently shaped aggregated cells, are as follows: 1. *Parenchyma*, cells of dodecahedral character, and whose transverse section is subhexagonal. The term has been applied to cellular tissue in general. 2. *Sphærenchyma*, spherical cells. 3. *Merenchyma*, spheroidal cells. 4. *Ovenchyma*, oval cells,—very common in herbaceous plants. 5. *Conenchyma*, conical cells, as in some hairs. 6. *Columnar* tissue, divided into *Cylindrenchyma*, where the cells are cylindrical, and *Prismenchyma*, where they are prismatic. This, when compressed, becomes *Muriform*, and when depressed, *Pinenchyma*. 7. *Prosenchyma*, fusiform, or spindle-shaped cells, as in bark and wood. 8. *Colpenchyma*, sinuous or waved cells. 9. *Cladenchyma*, branched cells, as in some hairs. 10. *Actinenchyma*, stellate or radiating cells. 11. *Dœdalenchyma*, entangled, branched, and tabular cells.

The size of cells varies greatly, not only in different plants, but in different parts of the same plant. The largest are about $\frac{1}{30}$ of an inch in diameter; the more usual size, however, is $\frac{1}{500}$, sometimes $\frac{1}{1000}$. Each cell is originally isolated with a completely investing wall, which, however, in some rare instances, is observed to be perforated. The passage of liquids in and out of the single cell is performed by endosmosis. The anatomy of the cell itself and the probable mode of reproduction will be referred to hereafter. Although cells have each a distinct wall, so that when two come in contact they are separated by a double partition, yet this, on the one hand, may appear to be single, and on the other, may become entirely absorbed, so as to form a continuous cavity. There may, at times, be a lateral communication between contiguous series of cells. Single cells, such

as the spores of certain aquatic plants, may have ciliæ or fine hairs, by means of which they can execute a progressive motion through the water. Under such circumstances, they have often been considered and described as infusorial animalcula.

PITTED TISSUE (*Bothrenchyma*) is a modification of cellular tissue caused by the unequal deposit of the thickening matter in the wall of the cell, leaving thinner portions, which, when viewed by transmitted light, appear like pores or pits. A spiral thread or fibre is sometimes found coiled up in the inside of the true cell wall, which, when the latter is dissolved, uncoils and exhibits itself in its true character. Such cells, called *spiral cells* (*Inenchyma*), are frequent in the orchidaceous and cactaceous plants. This fibre varies from $\frac{1}{2000}$ to $\frac{1}{10000}$ of an inch in diameter, and is solid, with a cross-section of various shape. The coils of the spire are sometimes broken up and recombined in various ways, so as to appear as rings, reticulations, bars, or dots, thus producing *annular*, *reticulated*, *scalariform*, or *dotted* cells.

Cells are sometimes aggregated so closely together as to leave no visible interspaces, the tissue being then termed *perfect Parenchyma*. *Imperfect Parenchyma* is where the cells touch at certain points only, leaving intervals, which, when regular and continuous, are called *intercellular passages or canals*; when irregular and limited, *intercellular* spaces or *Lacunæ*. A division of cellular tissue is sometimes made into *Parenchyma*, where the cells fit together by plane faces, as in the pith and outer bark, and *Prosenchyma*, where the cells are fusiform, this being confined to the inner bark and wood. The mode in which the combination of cells is effected, varies under different circumstances; sometimes they are simply approximated and fused together, sometimes united by an intercellular matter which, in sea weeds, forms a considerable part of the bulk of the plant.

The external investment of the cell is composed of an unazotized primary matter, termed *cellulose*. This is lined by an originally mucilaginous matter containing nitrogen, called *Protoplasm*, and inside of this is the *Cytoblastema*. A weak solution of iodine applied to the young cell causes the protoplasm to turn brown and leave the cellulose. The tissue is further modified by the addition of various matters, the most important of which is *Sclerogen* or *Lignine* applied on the inside, the substance to which wood owes its hardness. This consists of C35, H24, O10, and may be dissolved by hot nitric acid. In all cell deposits there is a more or less tendency to a spiral arrangement.

Each cell will be found to contain, at one perod of its existence, a small body called a *nucleus*, this often embracing one or two minute dots called *nucleoli*. This nucleus may either lie free in the cell, or be attached by threads, or fastened directly to the cell wall. Some recent authorities of great weight, however, deny the existence of a primordial nucleus in every cell.

In addition to the carbon, oxygen, hydrogen, and nitrogen, found universally as the constituents of the cell, there are other materials more variable in their appearance and amount, as *Sulphur*, *Phosphorus*, *Potash*,

Soda, *Lime*, *Alumina*, *Magnesia*, *Silica*, and *Iron*; more rarely Iodine, Chlorine, Copper, Bromine, and Manganese. These will be subsequently referred to more at length. *Starch* is included in the cells of all plants at some period of their existence, and forms one of the most important distinctive characters between the animal and vegetable tissues. *Crystals* also, or Raphides of various shapes and characters are found in the interior of cells, either lying loose or suspended from the walls. Sometimes there will be a single large crystal in a cell, and again several may be inclosed together. They abound in certain plants, as Cacti, to such an extent, as to exceed in weight the other constituents of the tissue. The raphides are all formed by the action of organic acids, as phosphoric, oxalic, &c.

Jelly is another occasional element of cells. This is hard and horny when dry, slowly soluble in water, and unacted on by iodine. It sometimes fills particular cells, as in the stems of some Cacti. It is to this substance that carrageen moss and other plants owe their gelatinous properties. *Chlorophylle*, the green coloring matter of plants, and *Chromule*, the coloring matter not green, are additional contents of cells.

Various and quite conflicting opinions have been propounded by different eminent vegetable physiologists as to the development (*Cytogenesis*) and functions of cells. Perhaps the more generally received opinion is, that in the blastema, or primordial matter, the nucleus, which is itself a minute cell, is first formed, and exerting a directing influence upon the inclosing matter, causes it to assume a cell-shape. With the absorption of new matter from the blastema the nucleoli increase in size and finally separate, each one forming around itself new cells, which, enlarging, burst the original cell. The new cells contain nucleated nuclei, by means of which the same operation is repeated, the increase taking place in a determinate direction. This constitutes the *endogenous* theory of cell development. The exogenous theory supposes an influence to be exerted by a cell on the surrounding matter, resulting in the addition or aggregation of new matter. This view does not require the existence of a nucleus. According to others, again, the old cell becomes separated by a constriction, or a projecting partition, into two cells, each of which may or may not include a nucleus. This is the merismatic or fissiparous theory. Many attribute to electric currents, produced by the various chemical actions, the influences which cause the different cell phenomena. The development of cells sometimes takes place with extraordinary rapidity, especially in the Fungi. Thus, in *Bovista gigantea*, they have been supposed to be produced at the rate of sixty-six millions in a minute.

2. Vascular Tissue.

Vascular Tissue, or Angienchyma, consists of tubes whose length greatly exceeds their breadth. They may be formed of membrane only, or of membrane variously modified. *Woody fibre*, or *ligneous tissue* (*Pleurenchyma*), consists of tubes or elongated cells, of a fusiform or spindle-shape, with the walls greatly thickened by sclerogenous deposits.

These overlap each other, and are so combined as to give great strength and firmness to the plant. It differs from simple cellular tissue in its cylindrical and elongated form. The term *Prosenchyma* is properly applied to short fusiform cellular tissue. Woody tissue is found in wood, in the inner bark, and in the skeleton of the leaf, and may be separated from the other portions of the plant by maceration. It is thus that flax, hemp, and linen (all of them forms of ligneous fibre) are obtained. Cotton, on the other hand, consists of elongated cells or hairs, which collapse on drying, and twist spirally, as seen under the microscope, this constituting an excellent test to distinguish the latter from the former. Common pleurenchyma presents no markings; in glandular, on the other hand, the tubes exhibit discoid depressions on the outside of the wall. The depressions of two contiguous tubes are generally opposite to each other, and thus inclose a doubly convex lenticular space. In some cases there is a secondary depression in the bottom of the primary, which, when viewed by transmitted light, appears as a light circle inside of a darker one. This glandular or punctated woody tissue is exhibited in all the Coniferæ, and serves as an excellent microscopical character for fossil woods.

Fibro-vascular Tissue (*Trachenchyma*) consists of tapering membranous tubes, and having either a spiral fibre inclosed, or else markings of rings, dots, or bars, arranged in a more or less spiral form. This tissue occurs especially in the medullary sheath, and in the veins of the leaves. True Spiral Vessels (*Spiroidea*) exhibit themselves as elongated tubes, overlapping at the conical extremities, with a spiral fibre on the inside, not on the outside, as has been erroneously stated. The thin outer membrane consists of pure cellulose. The point where two successive spiral vessels overlap is sometimes absorbed, so as to present a free communication. The internal fibre is generally single; more rarely a greater number, as from two to twenty are combined, so as to present a band constituting *Pleiotracheæ*. The spiral generally turns from right to left. The coils may be separated or united: this union among each other, and to the sides of the vessel, may be so close as to constitute *closed* tracheæ.

Spurious Tracheæ, or ducts, are vessels in which the internal spiral is broken up and variously modified. A principal variety is the *annular*, where the broken coils are combined into rings, which may be horizontal or oblique, simple or branched, contiguous or remote. In *reticulated* vessels separate fibres run into each other on the walls of the tube; when the fibre is broken up into short pieces which adhere to the walls, the vessel becomes *dotted*. In *scalariform* vessels the pieces of the fibre are shorter, and passing transversely, and nearly parallel across the vessel, present an appearance not unlike that of the rounds of a ladder. Such vessels are generally prismatic, as in Ferns, the angles being unmarked.

In Vasiform Tissue (*Bothrenchyma*, or *Taphrenchyma*), the vessels exhibit an appearance of pores on the surface. These vessels consist of cylinders, more or less elongated, in which the thickening matter is so deposited as to leave part of the membrane uncovered, thus causing the porous or pitted appearance.

Laticiferous Tissue, or *Cinenchyma*, consists of long homogeneous tubes, branching and anastomosing like the blood-vessels of animals. Their walls exhibit no markings, but vary in thickness. They contain and conduct a granular liquid matter called *latex*, which, at first transparent, subsequently becomes variously colored. Physiologists differ as to the origin of these vessels, some supposing them to be formed by linearly arranged cells, whose walls are absorbed at the extremities, so as to form a continuous tube in which the latex subsequently flows; while others, again, maintain that the current is first established in the intercellular spaces, and that the inclosing wall is formed afterwards.

There are no elementary forms of tissue other than those already mentioned, the rest being simple modifications of the above. The various *air vessels*, *cysts*, *reservoirs of secreted matter*, &c., are either intercellular spaces, or cells filled with air or with peculiar secretions. The air cells are seen in peculiar modifications in the stems of many water plants and grasses.

II. COMPOUND ORGANS OF PLANTS.

I. Organs of Nutrition or Vegetation.

1. *The General Integument.*

By the term *General Integument*, is meant the external cellular covering of the plant, composed, in most cases, of two layers, the *cuticle* and *epidermis*.

The *Superficial Pellicle*, or *Cuticle*, is a very thin continuous membrane spread over the epidermis, and investing all parts except the stomata, down whose cavity, however, it sometimes dips, forming a very delicate lining. Some physiologists, with Mohl at their head, do not admit this as a separate membrane from the epidermis, supposing it to consist of the external coat of the cell thus separated from the protoplasm; others, again, suppose it to be a secretion from the cell, which, forming first on the inside, transudes to the outer surface. The *epidermis*, which lies subjacent to the cuticle, is found on all parts of the plant exposed to air excepting the stigma. In parts habitually submerged it is replaced by a simple cuticle. The epidermis is composed of cells, generally tabular, and arranged in a greater or less number of layers, these cells being bounded by flexuous or straight lines, containing either a colorless liquid or other substances, as resinous matter, wax, silica, carbonate of lime, &c. The *stomata* are openings between some of the cells of the epidermis, by which a communication is established between the air and the subjacent parts. They generally consist of two semilunar cells, surrounding an oval slit, as lips inclose the mouth. They open and close according to the greater or less amount of moisture in the atmosphere. The stomata communicate with intercellular spaces, lined by the above-mentioned prolongations of the cuticle, called *cistomata*.

Stomata occur on all portions of the plant, especially in the green parts. They rarely exist in the Cellulares or in pale parasites, and never in roots and etiolated plants. The number varies greatly in different portions of the same plant, being, however, greatest on the under side of leaves exposed to the air, and yet sometimes entirely wanting on the upper surfaces. In floating leaves the stomata only occur on the upper surface. The following table exhibits the number of stomata to the square inch on the leaves of several plants :

Plants.	Upper Side.	Under Side.	Plants.	Upper Side.	Under Side.
Mistletoe . . .	200	200	Yucca . .	40,000	40,000
Tradescantia . .	2000	2000	Mezereon .	none	4000
Rheum palmatum	1000	40,000	Pæony . .	none	13,000
Crinum amabile .	20,000	20,000	Vine . . .	none	13,600
Aloe	25,000	20,000	Lilac . . .	none	160,000
Clove Pink . .	38,500	38,500	Holly . .	none	63,000

Various processes are seen at times on the surface of the epidermis by the outward enlargement or projection of some cells. When these are more considerably elongated they constitute hairs (*pili* or *villi*), and are covered by the cuticle as by a sheath. They are either *lymphatic* or *glandular*, the latter distended at the base or apex, to receive certain secretions. In respect to position, hairs are *erect* or *oblique*, or else lie flat along the surface (*adpressed*); when attached by their middle, they are *peltate*. They may be composed of a single cell, which is either *simple*, *forked*, or *branched* ; or else of several cells, which are either placed end to end, as in *moniliform* hairs, or united laterally into a compound cone, *compound* hairs, or *branched*. When several hairs proceed from a common centre, they are said to be *stellate* or *radiated*. These, when close pressed together, so as to form a discoid expansion, constitute a *scale* or *scurf* (*lepis*); the surface is then said to be lepidote. This character is well seen in Hippophae. A chaffy substance, surrounding the base of the leaves of ferns, consisting of elongated flattened cells, is constituted by *ramenta* or *ramentaceous* hairs : a similar substance in palms is called *reticulum* or *mattula*. Prickles (*aculei*) are hardened hairs, connected solely with the epidermis. These differ from thorns, which are stunted branches, and are connected with the wood. *Setæ* are bristles or stiff hairs ; the surfaces on which they occur are said to be *setose* or *setaceous*.

Hairs, in regard to their form, are *clavate*, or *club-shaped*, when they expand gradually from the base to the apex, or are thickened at the apex ; when there is a distinct rounded head, they are *capitate ;* when they have slight projections on the surface, they are *scabrous ; hooked* or *uncinate*, when with a hook at the apex turned downwards ; *barbed* or *glochidiate*, with two or more hooks around the apex ; *peltate*, when attached solely in the middle ; *ciliate*, when surrounding the margin of leaves.

Hairs are found on various parts of plants, even in the interior, and

different names are given to surfaces, according to the degree to which hairs are developed, as well as according to the nature of the hairs themselves. Thus, a surface is *glabrous*, when there are no hairs whatever; *pilose* or *hairy*, when such exist; *villous*, when the hairs are long, weak, and often oblique; *sericeous*, when the hairs are long and adpressed, with a silky lustre; *hispid* (*hirtus*), when the hairs are long and stiff, but not adpressed; *hirsute*, when they are long, but neither stiff nor adpressed, *velvety* (*velutinus*), when there is a dense covering of short down, like velvet; *tomentose*, when the surface is covered with crisp, rather rigid entangled hairs, like cotton, forming a kind of felt; *woolly*, when the hairs are long and matted, like wool; *bearded* or *stupose*, when the hair occurs in small tufts.

As *glandular* hairs differ in nothing but form from true *glands*, we shall consider both together. A *gland* is a cavity in the epidermis, with variously shaped walls, usually inclosing a peculiar secretion. When supported on a stem, glands are *petiolate*, *stipitate*, or *stalked;* when without this, they become *sessile*. *Stalked glands*, or *glandular hairs*, are composed either of a single cell, dilated at the apex, or of several combined. The gland is sometimes situated at the base of the hair, which is perforated to receive the secretion, as in the common nettle. Here the apex is closed by a solid cap, which breaks off at the slightest touch, leaving the poison to pass into the wound.

Glands sometimes occur as secreting cells surrounding a pit or depression. These communicate with the surface by means of a canal. Sometimes only the apex of the gland comes to the surface, at others it is entirely below; in this latter case the gland is *vesicular*. *Warts* (*verrucæ*) are collections of thickened cells on the surface of plants, containing various matters. *Lenticels* are cellular projections on the surface of bark, arising from its inner portion.

The object of the epidermis and its appendages is to protect the plant from noxious influences, whether atmospheric, meteorological, or animal. Thus, in dry climates it is very thick, and coated with a waxy secretion, to prevent the loss of water. The stomata permit the escape of fluid from the interior, and exhibit a compensating contrivance, by which, when the plant is distended with liquid, they are opened to their utmost, closing more and more with the loss of moisture. A communication is kept up between the air and inner bark by means of lenticels, which thus perform the functions of stomata. The young roots are produced from them under certain circumstances. Some hairs occurring on the stile of flowers are called *collecting* hairs, from the office they possess in taking up the pollen. In many hairs, especially in those of Tradescantia or spider wort, a circulation of fluids may readily be seen to take place, called *Cyclosis*.

2. *Descending Stem or Root.*

The truly compound organs of the plant are the axis and its appendages.

the epidermis and its appendages being merely the general investment. The axis consists of a *root* and a *stem*, growing generally in diametrically opposite directions. The axis is produced by the development of a spore, an embryo, or a leaf-bud, in two opposite directions. A *spore* is a young plant produced in the interior of another, without any agency of sexes, and having no determinate point of growth. An *embryo* is a young plant produced by the agency of sexes, and situated within a seed, having a determinate point or points of growth. A *leaf-bud* is a young plant produced without the agency of sexes, inclosed within rudimentary leaves or scales, and developed on the outside of a stem. The spore and embryo propagate the species in the person of distinct individuals; the leaf-bud propagates the species in the form of an aggregation of individuals. When the vital action of either spore, embryo, or bud, is excited, development takes place upwards, downwards, and laterally or horizontally; in the first case causing an elongation of stem, in the second of root, in the third producing an increase in thickness.

The *root*, or descending *axis*, is distinguished from the stem by the absence of normal buds and of stomata; in exogens there is generally no pith, although a medullary system is present. The objects of the root are twofold: to fix the plant firmly in the earth, and to absorb nutritious substances from the soil. Although roots are generally *subterranean*, they may sometimes be *aerial*. Such roots occur in *epiphytes*, or air plants, as also in species of Ficus, well shown in the Indian Banyan. In this case they are called *adventitious*, or *abnormal*. Green-colored aerial roots contain stomata. In certain parasites, as the Dodder or Cuscuta, roots are sometimes produced in the form of suckers, which enter the cellular tissue of the plant preyed upon. Roots exposed for a long time to the air, sometimes lose their fibrils and develope abnormal buds.

The *form* of roots varies exceedingly with the manner in which the axis descends and branches. When this central axis goes deep into the ground, tapering towards the apex, and without dividing, a *tap root* is produced. When this tap root becomes somewhat shortened, and at the same time succulent, it constitutes the *conical* root, as in the carrot; when there is a slight rounding at both extremities, instead of a straight outline, the root is *fusiform*, as in the radish; when the axis is much shortened in proportion to the thickest diameter, we have the *napiform* root of the turnip; if the root end abruptly, as if bitten off, it is called *præmorse;* it may also be *twisted*.

When the descending axis is very short, and at once divides into a number of nearly equal thin fibrils, the root is *fibrous*, as in many grasses; when these fibrils are short and succulent, the root is *fasciculated;* when the fasciculi are uniform and arranged like coral, the root is *coralline;* when some of the fibrils are developed in the form of starchy tubercles, the root is *tubercular;* it is *nodulose* when the fibrils enlarge in certain parts only; *moniliform* when the enlargement is at regular intervals, and of nearly equal size, like a string of beads. The root may also be *annulated*, when divided by constrictions into partial rings; *placentiform*, when

expanded like a cake; *testiculate*, when there are two large tuberoid roots of nearly equal size.

3. *Ascending Axis, or the Stem.*

The stem is the part of the plant usually exposed above the ground, and bearing the leaves and flowers; it is produced by the successive development of leaf buds in a longitudinal and lateral direction. The stem bears different names, according to the character of the plant. Thus, in ordinary herbaceous plants, it is called *caulis;* in the case of trees, *truncus;* in shrubs, *caudex;* in grasses, *culm;* in palms and ferns, *stipe.* When a distinct stem is present, the plant is called *caulescent*, when it is absent, *acaulescent.* True stems are sometimes absent in certain plants, which consist merely of expansions of cellular tissue, in the form of aggregations of cells. Such are called *Thallogens*, or *Thallophytes*, and are represented by Chara, Conferva, and Alga.

Stems, although more generally firm and erect, are sometimes weak, and either lie prostrate (*procumbent stems*), or climb like the ivy by means of suckers (*scandent*), or twist round other plants (*volubile*). The direction of the twist may be either from right to left, as in Convolvulus, or from left to right, as in the Honeysuckle. Some plants exhibit both directions alternately. The twining plants have generally herbaceous stems; some, however, are woody, as the Clematis, Vine, Honeysuckle, &c., whose stems are called *Sarmenta.* Woody climbers are very common in tropical climates, where they are called *Lianas.* In some cases, the lateral extension exceeds the longitudinal, as in Testudinaria and some Cacti.

There are certain points along the stems, at which leaf buds and branches appear; these are called *nodes*, and generally occur symmetrically. The spaces between the nodes are called *internodes.* A branch is but the development of a leaf bud from one of the nodes. *Spines* are abortive branches, and, in many cases, by change of culture, may be developed into leaf or fruit bearing branches.

When the stem is woody and continues to increase indefinitely, we have either *trees* or *shrubs;* trees when there is but one stem, shrubs when there are several stems, mostly of equal size, springing up together from the ground. A division of the shrub is sometimes made into the *true shrub* (*frutex*), where there is a short stem; *under shrub* (*suffrutex*), where this is hardly evident; and *low shrub* (*dumus*), where the whole plant is low and spreading, the branches springing up together as a multitude of stems at or near the ground. The equivalent terms are arborescent, fruticose, suffruticose, and dumose.

The transverse section of the stem, though generally circular, may be oval or even bounded by straight lines and angles. The various terms applied are, *terete; half-terete; compressed; plano-compressed; two-edged; acute-angled; obtuse-angled; triangular; quadrangular; quinquangular; octangular; multangular; triquetrous*, &c., whose significance is sufficiently evident, with the exception, perhaps, of the last, which refers to a stem with three concave faces.

The stem does not always stand in the air (*aerial*); it is sometimes below ground (*subterranean*). The latter are sometimes called roots; true roots, however, differ from these, in never possessing scales (rudimentary leaves) or nodes, from which may be developed eyes (rudimentary buds). The *crown of the root* is a shortened stem, often partly subterranean, and remaining in some plants after the upper portions have withered. This it is which constitutes the persistent portion of the ascending axes of the perennial plant. Here the internodes are very short, and the nodes crowd so closely together that there appears to be no stem. A *rhizome* or *root-stock* is a stem running along the surface of the ground, partially covered with soil, and sending out leaf buds from the upper side, and roots from the lower. This is seen in ferns, iris, &c. A *pseudo-bulb* is an enlarged bulbose aerial stem, and is succulent, sometimes with numerous spiral cells and vessels, and a thick epidermis. A *soboles* is a creeping subterranean stem, sending roots from one part, and leaf buds from another. A *tuber* is produced by a swelling of the internodes, caused generally by a deposit of starchy matter, as in the potatoe. The eyes of the potatoe are the leaf buds on the abbreviated and highly expanded stem. A *corm* is a solid underground stem, which, of a roundish form, neither creeps nor roots, and is invested by series of imbricated scales, as in the tulip. It developes a second corm to one side, which feeds on the first and destroys it, itself to be devoured in turn by a successor.

Stems, with respect to their structure, are either exogenous, endogenous, or acrogenous. *Exogenous* stems (*exogens*) are those which increase indefinitely by layers applied to the outside. Stems are *endogenous* (*endogens*) when the bundles of vascular tissue are produced in definite fasciculi, and converged towards the interior, all additions being made in the interior. In the *acrogenous* stem (*acrogens*) the vascular bundles are all developed simultaneously, and not in succession, the elongation of the stem depending on the union of the basis of the leaves or the petioles, and the extension of the growing point or summit. In addition to the above, we have *thallogenous* plants (*thallogens*) where there is simple elongation or dilatation, without leaf buds or leaves, and *dictyogens*, where the stem has the structure of endogens, and the roots nearly that of exogens, as in Smilax. We shall now refer to these more particularly; premising, however, that there are modifications of the embryo which run parallel to those of the stem, the exogen having a germ with two seed lobes or cotyledons (hence dicotyledonous); the endogen, one with but a single cotyledon (monocotyledonous); and no lobe whatever in the acrogen (acotyledonous).

In the exogenous or dicotyledonous stem, we have the type of most trees of temperate climates, embracing both a cellular and vascular system. The cellular system includes the outer bark, the medullary rays, and the pith; the vascular the inner bark, the woody layers, and the medullary sheath. In the earlier stages of growth the young exogen is almost entirely cellular; after a time, however, we perceive wedge-shaped bundles, edges of which point towards a common centre, arranged around a central cellular mass called *pith*, which is connected with the outer bark by means of cellular

processes called *medullary rays.* At first the pith is large, and occupies a large proportion of the plant; the medullary rays, also, are of considerable thickness; subsequently, by the increase of the old wedges and the development of new ones between them, the medullary rays become more restricted. Such is the structure of a young shoot during the first year. At the end of the second year, the shoot is found to have increased in diameter by the formation of a zone of vessels consisting of porous and woody tissue, and a zone of fibrous bark, the medullary rays being continued from within outwards, the number of such zones increasing year after year.

Taking up the components of stem in proper succession, we begin with a more particular examination of the *pith.* This, the central portion, consists of cellular tissue, the cells, often hexagonal, diminishing towards the circumference. Pith is at first of a greenish color, and full of fluid; subsequently this disappears, leaving a light colored, spongy, dry mass. Sometimes, in drying, it separates into regular cavities, as in the Walnut and Jessamine; in this case it is said to be *discoid* or *disciform.* More frequently the cavities, when they exist at all, are of irregular shape. Occasionally there are vessels in the pith; sometimes, also, regular deposits. The elder exhibits an abundant pith; rice paper consists of sections of pith, the exact origin of which is, however, still undecided; some ascribe it to a species of Æschymomene. The object of the pith is to furnish nourishment to the young buds, for which purpose it is often filled with dextrine or starch, convertible into sugar by the process of vegetation. When the woody circle of the first year is complete, the pith remains stationary as to size ever afterwards.

The *medullary sheath* consists of fibro-vascular or spiral vessels immediately including the pith, projections of which pass through this sheath into the medullary rays. A few woody fibres are usually intermingled with the spiral vessels. This sheath is in direct communication with the leaf buds and the veins of the leaves, and carries up oxygen liberated by the decomposition of carbonic acid or of water, conducting it into the leaves.

Woody Layers. During the first year, the vascular cylinder consists of an internal layer of spiral vessels forming the medullary sheath, and external bundles of porous and ligneous vessels. Subsequently, the layer of spiral vessels is not repeated, but concentric zones of porous vessels and of pleurenchyma are formed, constituting, in the tree, the woody circles. Exogenous plants are sometimes termed *cyclogens*, from their exhibiting these concentric circles. A transverse section of a branch or trunk of a tree usually shows these concentric circles very clearly, each one of which is generally supposed to represent the growth of a year. The circle of large pores usually seen to separate contiguous layers, is composed of the mouths of porous vessels. The distinctness, as well as the size of these circles, varies in different plants, and even in different parts of the same section. Neither is the number of rings in a cross-section to be taken as an indication of the true age of a tree, since there is good reason for supposing that two and even more rings may be formed in a single year, while one ring may occupy

two years in its formation. The rule is liable to fewer exceptions in the trees of temperate climates, where there are well defined periods of heat and cold alternating once in the year. Not only the size but the texture of the woody layers varies in different parts of the same cross-section. The vessels, at first open and admitting a ready passage to the juices of the plant, ultimately become thickened and possibly entirely filled by the deposit of hard matter. It is this which constitutes the distinction between *duramen* or *heart-wood*, and *alburnum* or *sap-wood*, the latter being exterior to the former, lighter colored, and less compact. In some trees, as Tilia, the chestnut, and others, no such distinction is readily evident. The thicker the tree the greater is the proportion of heart-wood in the cross section. It is the heart-wood that constitutes the most useful portion of timber, owing to its greater strength and less tendency to decay.

The *cambium* is a layer of semifluid matter which marks the separation between the wood and the bark. This is an organizable mucilage, and from it new elementary organs are formed, whether these consist of vascular or of cellular tissue.

The *bark* (*cortex*) lies external to the wood, and like it, consists of several layers. At first it is cellular, like pith; subsequently it becomes more or less altered by secondary deposits. While composed of a cellular and vascular system, like the wood, the position and relative proportion of the elements vary in the two. In the bark the cellular system is external and much developed; in the wood it is internal and restricted. The cellular portion consists of an external layer of *epidermis*, already described, then one of *epiphloeum*, within which is the *mesophloeum*; the vascular portion of the internal layer is called *liber*, *endophloeum*, or true bark.

The *endophloeum*, or *liber*, is composed of pleurenchyma, mixed with laticiferous vessels and cellular tissue, resting on the alburnum. The tubes of the pleurenchyma are often thickened by deposits of secondary matter in concentric cylinders, thus acquiring a considerable degree of tenacity, as in the Lace tree, the Linden, the Paper mulberry, &c. The mesophloeum lies immediately outside of the liber, and consists of polyhedral cells, usually containing chlorophylle, sometimes raphides. The *epiphloeum* is the outer covering of the bark, the epidermis excepted, which is often absent, and consists of cubical or tabular cells, without chlorophylle; the elongation of these cells is horizontal, thus differing from the cells of mesophloeum. Usually of a single layer of cells, epiphloeum sometimes exhibits several, as in the bark of the cork tree, or the cork of commerce.

The increase of bark takes place in a manner directly opposite to that of the wood. In the latter, new layers are developed on the outside of the old ones; in the former, on the inside of the several portions. Thus the outer layers of bark become distended, and if elastic, retain their continuity, as in the beech; if not elastic, they either become fissured and crumbled off, or they exfoliate in patches, as in some species of Hickory, Birch, and Buttonwood. An incision in the wood of a tree is deepened with increasing age; if in the bark, it gradually becomes shallower and shallower, finally disappearing.

The *medullary rays*, or *plates*, or the silver grain of carpenters, keep up a communication between the bark and the pith, these being generally separated by vascular layers. They consist of cellular tissue, which has been gradually compressed, so as to give a muriform appearance to the cells. The space they occupy, at first large, is diminished more and more with increasing age. A transverse section of a woody stem presents the appearance of narrow lines running from the centre to the circumference. A longitudinal section shows that these rays are not laminæ continuous from one end to the other, but are broken up by the intervention of woody fibres.

We have thus described the normal character of the exogenous stem. There are, however, certain anomalous appearances in certain plants, which are not readily reducible to rule. In place of the concentric arrangement of the vascular layers, there are sometimes only a few rows of wedge-shaped bundles, and additions made by the interposition of new bundles, just as in the young herbaceous normal stem; sometimes these vascular bundles are arranged in zones. Again, in some cases the separating layers are cellular, not fibrous; sometimes the woody layers are arranged in a very irregular manner. In some Bignonias the layers are divided into four wedge-shaped portions, probably by an introversion of the liber. In Paullinia a central woody mass is sometimes surrounded by others likewise cylindrical. In some Malpighiaceæ, the outer surface, instead of being cylindrical, exhibits very irregular lobes and indentations.

The stems of *endogenous* plants present many features different from those which we have found to exist in exogens, and especially in that there is no absolute or visible distinction into pith, medullary rays, wood, and bark. There is an intermixture of bundles of fibro-vascular tissue among a mass of cellular tissue, the whole overlaid by a zone of denser cellular and woody tissue, inseparable from the stem. In the young plant the centre of the stem is occupied entirely by cells, around which the vessels are grouped, increasing in number towards the circumference. The central cells are sometimes ruptured and absorbed, leaving a cavity; more generally, however, they are persistent, becoming gradually encroached upon by the increasing vascular system. The external layer of the endogenous plant occupying the place of bark, and known as *false bark*, is a dense layer of cellular tissue, into which the lower ends of the vascular fibres dip, losing their vascularity as soon as they reach it.

The opinion originally entertained that the new layers of vascular fibres were developed inside the old ones, and pushed these out towards the cortical envelope, appears not to be strictly correct, as, although at first they are thus internal, yet, subsequently, they curve outwards to run into the exterior, as already mentioned. After all, the true distinction between exogenous and endogenous stems consists in this: in the former, the woody or vascular layers increase indefinitely at their periphery; in the latter, they are arrested in lateral growth at a definite epoch. When it is one terminal bud alone of an endogen that developes, the stem may be truly cylindrical; when several develope, however, the stem will be conical. A

single terminal bud, as that just referred to, an example of which is to be found in the Palm, is called a *phyllophor*, or *phyllogen*. From this bud are developed the leaves with which the vascular bundles are connected, forming, as it were, their roots; when the leaves of one bud decay another is produced in the centre, the bases of the leaves, as they die and fall off, leaving a scar on the stem. There is no way of determining the age of an endogen, a palm for instance, by examining a cross-section, since there are no rings of growth; an approximation may, however, be found from the known length of the tree, elongation proceeding pretty uniformly, and at a determinate rate for different species. Occasionally there are several terminal buds, which may cause a dichotomization or branching of the plant; in many, however, there is but a single one, whose decapitation is followed by the death of the tree.

The third kind of stem, the *acrogenous*, or *acotyledonous*, is, in general appearance, not unlike that of most endogens, in being unbranched, of nearly uniform diameter, and bearing a tuft of leaves at the summit; the internal structure, however, always furnishes a ready means of distinction. Acrogens are rarely arborescent; a good illustration is, however, to be found in the Tree Fern, the stem of which is called a *rachis* or *stipe*. A transverse section exhibits a circle of vascular tissue, composed of masses of various forms and size, near the circumference; the centre is either hollow or formed of cellular tissue. On the outside of the vascular circle there are cells covered by a cellular integument, representing an epidermis, often very compact, and formed originally of the bases of the leaves. The vascular bundles are all formed simultaneously, and their number depends upon that of the individual leaves or petioles. Although the acrogen is said to grow only from the top, yet, strictly speaking, there is a slight increase in diameter, as is shown in the separation of the rhomboidal leaf-scars, which originally were in contact. These *scars*, or *cicatrices*, are generally arranged in spiral series around the stem, which always carries their traces.

In *thallogens*, which are simple expansions of cellular substance, sometimes in definite directions, sometimes in all directions, there is no axis whatever, nothing but threads woven together or separate, or else cells, lobes, plates, or enlargements of various kinds.

A few words as to the functions of the different parts of the stem must conclude this portion of our subject. The office of the pith, as already mentioned, is to convey nourishment to the young plant. By means of the medullary sheath a connexion is kept up between the central parts of the stem and the leaves, by means of spiral vessels, part of whose object may be the transmission of air. The medullary rays preserve a communication between the bark and the pith, and are directly connected with the formation of leaf buds and the matter of the cambium. The bark protects the tender wood, conveys the elaborated sap downwards from the leaves, and is the medium in which many of the secretions are deposited. By means of the vascular bundles the crude sap is conveyed from the roots to the leaves. In woody fibre these bundles become ultimately choked up by the secondary deposits.

4. *Leaves and the Appendages.*

A leaf is a symmetrical lateral expansion of the bark, and is intimately connected with the internal part of the internal axis. Leaves, at first, are mere projections of cellular tissue, closely united to each other; subsequently they enlarge with the addition of vascular tissue, and finally assume a permanent form and position along the axis. Whenever a leaf-bud is formed, a leaf is also; this, if not entirely developed, is at least rudimentary. Two essential modifications of the leaf have been observed according as the medium of existence is air or water.

In *aerial* leaves we have a skeletal vascular tissue in the form of veins, ribs, or nerves, the interspaces filled up by cellular tissue in the shape of parenchyma, the whole invested by epidermis. The vascular system is continuous with that of the stem; the vessels from the interior of the stem spread out on the surface, the more external in the former appearing on the inferior face of the latter. This is well illustrated by the fact, that in the upper part of the leaf we find spiral vessels and woody fibre, in the lower there are laticiferous vessels and fibres like those of liber. The vascular system is distributed in the form of simple or branching veins.

The *epidermis* generally differs on the two sides of the leaf. Thus, it is on the under face that the stomata are found in largest quantity, sometimes exclusively; hairs also are of much more frequent occurrence. In leaves floating on the surface of water the stomata are superior. The *parenchyma* of the leaf is that cellular tissue filling up the interspaces of the vascular fibre. Other names are *diachyma* and *mesophyllum*. This parenchyma exhibits two series of cells, different in form and arrangement.

Submerged leaves, or those developed under water, exhibit many points of difference from aerial leaves. There is here no fibro-vascular system, but merely an aggregation of cells, which sometimes simulate veins. There is no true epidermis, nor are there any stomata. Sometimes there is only a net-work of filamentoid cells, the interspaces not filled with parenchyma. Such leaves are called *fenestrate*.

The ordinary leaf in its fullest form consists of an expanded flat portion, called the *blade*, or *laminar merithal;* of a narrower portion, called *stalk*, *petiole*, or *petiolary merithal*, which is continuous with the *midrib;* and sometimes of a portion at the base of the petiole, forming a *sheath* or *vagina;* the latter, again, may be developed in the form of small leaves, called *stipules*: When a leaf has a distinct stalk, it is said to be *petiolate;* when there is no stalk, it is called *sessile*. When sessile leaves embrace the stem they are said to be *amplexicaul*. The portion of the leaves next to the stem is the *base*, the opposite extremity is the *apex*. The surfaces of the leaves are called the *paginæ;* the edges or margin, the *circumscription*. The usual position of the leaf is horizontal; sometimes it is vertical, or else between the two positions. The upper angle, formed by the petiole with the stem, is the *axilla;* anything arising from that part is *axillary*. The petiole is sometimes articulated with the stem, leaving a scar on the latter when it falls;

in other cases it is continuous with the stem. When leaves fall off annually, or about the same time, they are called *deciduous;* when they remain for several years, or only fall singly through the year, they are *evergreen.*

By the *venation* or *nervation* of a leaf is meant the distribution of the fibro-vascular bundles in it. This may be traced in most cases, but instances occur, as in sea-weeds and other submerged plants, where true veins do not exist; such are said to be *veinless.* There is generally a more or less central vein larger than the rest, called the *midrib,* giving off lateral veins (*primary veins*), which either end within the margin, or else go entirely out to the edge. Smaller veins, given off by the *midribs,* are called *costal,* these giving origin to *veinlets.* Sometimes, instead of one central midrib, there are several large ribs diverging from the part where the petiole enters the blade. These give off secondary veins, which, in turn, furnish tertiary, all apparently anastomosing, and giving a reticulated appearance to the surface of the leaf. Such leaves are called *reticulated,* or *net veined.* *Parallel veined* leaves are those in which there is a central rib, giving off a single series of well defined veins, parallel to each other; or else there are several ribs which run from base to apex, nearly parallel to the edge of the leaf or to each other. Leaves of this kind are of usual occurrence in endogenous plants.

Leaves are either *simple* or *compound.* The simple leaf has but one articulation with the stem, and the incisions in the margin do not reach the midrib. The compound leaf has other articulations beyond that with the stem, or consists of leaflets separately attached to the petiole. All leaves at first are simple, and the nature of the compound character is intimately connected with the venation.

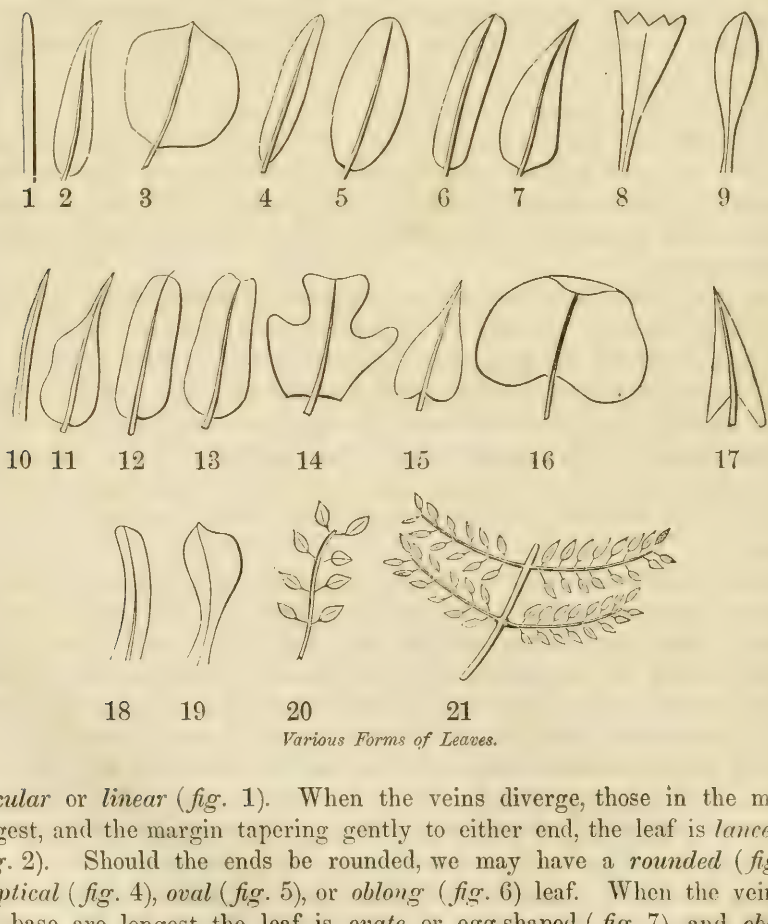
A simple leaf is *equal* or *oblique,* according as the midrib bisects the blade symmetrically or not. Should the margin be even, without divisions, the leaf is entire. When the projections are more or less irregular and pointed, the leaf is *dentate;* when arranged regularly, and like the teeth of a saw, we have a *serrate* leaf; *crenate,* when the serrations are rounded. Should the indentations of the margin extend about half-way to the midrib, the leaf is *cleft* (*fidus*), the segments are *fissures.* A continuation of the division to the midrib gives us a *partite* leaf, with *partitions* for the segments.

Should the divisions occur in a feather-veined leaf, this becomes *pinnatifid* when the divisions extend about to the middle, and are rather broad: *pectinate,* when they are narrow, like the teeth of a comb. Should the incisions extend to the midrib, the leaf becomes *pinnatipartite.* These primary divisions may again be subdivided, forming a *bipinnatifid,* or *bipinnatipartite* leaf; *tripinnatifid* indicates a still further subdivision. A pinnatifid leaf is *runcinate* when the divisions are sub-triangular, with the extremities pointed slightly backwards, as in the Dandelion. When the apex consists of a large rounded lobe, and the somewhat rounded divisions become gradually less and less towards the base, the leaf is *lyrate.* It is *panduriform* when, with a rounded apex, there is a concavity on each side, like that of a violin.

In a simple leaf, with *radiating* venation, we have *lobes* or *clefts* when the incisions extend about half-way to the base, a prefix being added to indicate the number, as *three-lobed* or *trifid*, *many-lobed* or *multifid*, &c. A leaf is *palmate* when the leaf is cleft only partly, so as to resemble a palm with short fingers; it is *digitate* when the divisions are deeper, and five in number, like long fingers; it is *dissected* when there are numerous narrow divisions extending nearly up to the base. A *pedate*, or *pedatifid* leaf, is one in which there are three primary divisions with two lateral, somewhat like the foot and toes of a bird.

In all the cases just considered the petiole is in the plane of the leaf. The petiole may, however, meet the leaf at an angle either right or acute. When the stalk is inserted into the middle of a tolerably entire leaf, this is *orbicular* in shape, and *peltate* in respect to the petiole; the term peltate is also applied to cases where the stalk is inserted within the continuous margin.

When a leaf is very narrow, with the edges parallel, as in the Pines, it is



Various Forms of Leaves.

acicular or *linear* (*fig*. 1). When the veins diverge, those in the middle longest, and the margin tapering gently to either end, the leaf is *lanceolate* (*fig*. 2). Should the ends be rounded, we may have a *rounded* (*fig*. 3), *elliptical* (*fig*. 4), *oval* (*fig*. 5), or *oblong* (*fig*. 6) leaf. When the veins at the base are longest the leaf is *ovate* or egg-shaped (*fig*. 7), and *obovate*

when those at the apex are longest. Leaves also are *cuneate* or wedge-shaped (*fig.* 8) *spathulate* (*fig.* 9), *subulate* (*fig.* 10); *acuminate*, or drawn out into a point of greater or less extent (*fig.* 11); *mucronate*, with the free extremity of the midrib projecting from the margin (*fig.* 12).

When the parenchyma is deficient at the apex, so as to form two rounded lobes, the leaf is *obcordate;* when the deficiency is very slight, it is *emarginate;* when the apex is merely flattened or slightly indented, the leaf is *retuse* (*fig.* 13). If the apex appear as if cut off, so that the margin is straight or obtusely angled, the leaf is *truncate* (*fig.* 14). A leaf is *cordate* when the petiole enters a base having a rounded emargination (*fig.* 15), and *kidney-shaped* or *reniform* when the apex also is rounded (*fig.* 16). When the lobes are prolonged downwards and acutely, the leaf is *sagittate* (*fig.* 17); *hastate*, when they proceed at right angles. When the veins of leaves spread out in more than one plane, and by the development of parenchyma a succulent leaf is produced, we may have *conical*, *ensiform* or sword-like, *prismatic*, *acinaciform* or scymeter-shaped (*fig.* 18), and *dolabriform* or axe-shaped leaves (*fig.* 19). The margin of the leaf may be *wavy*, *undulated*, or *crisped*, when it is puckered from a superabundance of cellular tissue. There are numerous other shapes of leaves, although these and their binary combinations are the most important; the rest will readily suggest themselves.

Compound leaves are leaves in which the divisions pass down to the midrib, so as to subdivide the leaf into smaller and distinct leaves, called *leaflets*. The midrib or petiole thus appears like a branch with so many distinct leaves, each articulated to it. When the compound leaf dies, it is generally the primary petiole that falls off, carrying with it all those secondary to it. Leaflets, like leaves, may be either sessile or supported on a distinct stem, called a *petiolule*.

A feather-veined compound leaf is said to be *pinnate* (*fig.* 20) when each one of the primary veins forms the midrib of a leaflet: *bipinnate* (*fig.* 21) when the secondary veins are midribs, and are articulated to the primary; *tripinnate* or *decompound* when the tertiary veins stand in the same relation to distinct leaflets: a leaf still further divided is *supradecompound*.

When a pinnate leaf has one pair of leaflets, it is *unijugate;* two, *bijugate;* many pairs, *multijugate*. When a pinnate leaf ends in a pair of pinnæ, it is *equally or abruptly pinnate* (*pari-pinnate*): a single terminal leaflet furnishes an *unequally pinnate* (*impari-pinnate*) leaf. When the leaflets are not directly opposite to each other, the leaf is *alternately pinnate:* it is *impari-pinnate* when the pinnæ are of unequal size.

In leaves with radiating venation, and in which each vein forms the midrib of a separate leaflet, we have a *tennate* leaf with three leaflets; *quaternate* with four; *quinate* with five, &c. Should the parenchyma connecting three ribs of a ternate leaf subdivide, so that each of these forms the midrib of a new leaflet, the compound leaf is *biternate;* another such subdivision gives a *triternate* leaf, &c.

The *petiole*, or that part of the leaf which unites the blade with the stem, consists of one or more bundles of vascular tissue, with a varying amount

of parenchyma; the manner in which the vessels enter the leaf, and their connexion with the stem, has already been referred to. Where the petiole joins the stem, there is generally a constriction, and immediately external to this, a swelling out, of cellular tissue. At other times the petiole is not thus articulated, but either is a continuation of the stem or embraces it. When articulated leaves drop, there is left a cicatrix or scar, which in many cases is permanent. The petiole varies both in length and strength. A compressed petiole, as in the Aspen, renders a leaf more sensitive to slight currents of wind. A *phyllodium* is a petiole compressed and extended vertically, so as sometimes to supply the place of a leaf. Sometimes the petiole of a leaf runs out into a *tendril* or *cirrhus;* more frequently there is no blade whatever to such a petiole.

A *stipule* is a membranous expansion or other process found on each side of the base of a petiole. When attached to a leaflet, it is called a *stipel.* Plants with stipules are *stipulate;* without them, *exstipulate.* No definite shape can be assigned to the stipule, its only characteristic being the position above mentioned.

Occasionally there are anomalous forms of petiole and leaf, which merit some special consideration. The true leaf is sometimes entirely absent, and its place supplied by phyllodia or by stipules. Scales frequently replace leaves, of which indeed they are to be considered as abortions. Several leaves sometimes unite together, forming a *connate* leaf; when the basal lobes of a leaf are united around the stem, it is *perfoliate;* when the laminæ of a leaf run down and are united to the stem, it is *decurrent.* The vascular bundles and parenchyma are sometimes separated or arranged so as to inclose cavities, as in the *tubular* or *fistular* leaf of the onion, as also in the *ascidia* or *pitchers* of such plants as Sarracenia or Nepenthes.

Leaves occupy definite situations on the plant, and have special names in different positions. When they arise from the crown of the root, they are *radical;* those on the stem are *cauline;* on the branches, *ramal;* on flower stalks, *floral.* The leaves first developed are *seminal;* those appearing subsequently, *primordial.*

The arrangement of the leaves on the axis follows in definite order, and is called *phyllotaxis.* Normally, the nodes from which the leaves spring are ranged in a regular spiral round the stem. The internode between several nodes may, however, be suppressed, so as to exhibit several nodes at the same height on the stem. When two leaves are thus produced, at the same level and on different sides of the stem, they are *opposite;* when more than two, *verticillate* or *whorled.* The imaginary line connecting the bases of one pair of opposite leaves often crosses rectangularly the corresponding line of the next pair; the pairs are then said to *decussate.*

When a lingle leaf is produced at a node, and each node is separated from the next by an internode, the leaves are *alternate.* When, in a spiral series of alternate leaves, one leaf is immediately below the third above it, the arrangement is *distichous:* when it is the fourth which stands in this relation, *tristichous.* In this spiral arrangement, there are two elements, the number of coils or turns of the spiral before one leaf is found to come

immediately above another, and the number of leaves arranged along this interval of the spiral. The relation of the two is usually expressed by a fraction whose numerator indicates the number of turns, and the denominator the number of leaves. Thus, a phyllotaxis of $\frac{2}{5}$ indicates that one leaf is immediately in a line below the 6th above it, or that there are 5 leaves in the series and 2 turns of the spiral. The generating spiral may run from left to right, or from right to left, both being occasionally found in the branches and stem of a plant; when it is the same throughout the plant, the arrangement is *homodromous ;* when different in the branches from the stem, *heterodromous.* Sometimes the phenomena are such as to give rise to the supposition of two generating spirals at the same time, as in certain opposite and verticillate leaves. The final cause of this spiral arrangement is to enable all the leaves to have a nearly equal exposure to light, and thus prevent anything abnormal in the growth of the plant, this being in great measure determined by the leaves.

The *buds* which are seen to form at different parts of the stem are of two kinds, *leaf buds* and *flower buds*, the former producing leaves, the latter flowers. The leaf buds consist of rudimentary leaves inclosing a *growing* vital point, which lengthens upwards or from the point of attachment. The *flower buds* consist of rudimentary leaves inclosing a *fixed* or stationary vital point.

The *leaf bud*, to which we shall here confine our attention, is, in external appearance, a collection of scales (rudimentary leaves) arranged one above the other in an imbricated manner. The centre or growing point which they inclose is cellular matter coated with a thin stratum of spiral vessels, the two answering to the pith and medullary sheath of exogens. By the growth of the leaf bud, branches are formed, such of the scales as are alive changing into leaves with the advancement of vegetation, and the evolution of the branch not slightly resembling the drawing out of the joints of a spy-glass. Leaf buds are formed in the axils of previously formed leaves; they may be *terminal* or *lateral.* The leaf buds may be made to grow on other plants than those from which they were originally developed, as in the process called *budding.* They may even detach themselves spontaneously from the axils of leaves, and germinate when planted in the ground. The tree may, in fact, be considered as an assemblage of leaf buds or *phytons*, which send out stems and leaves in one direction, and fibres in the other. In temperate climates the leaf buds are produced during autumn and winter, and protected from injury by the external *scales* (themselves rudimentary leaves), and occasionally by an additional downy or resinous investment.

The manner in which the leaves are arranged in the bud is called their *vernation, gemmation*, or *præfoliation.* This is constant for the same species. The leaves may be either placed in simple apposition, or folded or rolled up in various modes. In the accompanying figures, *a–g* represent vertical sections; *h–n* are horizontal. The dot represents the axis.

The vernation then may be *reclinate* (*a*); *circinate* (*g*); *conduplicate* (*b*); *plicate* or *plaited* (*c*); *convolute* or *supervolute* (*d*); *involute* (*e*); *revolute* (*f*). With regard to the combination of leaves in a bud, they may be *valvate* (*h*); *imbricated*, *twisted*, or *spiral* (*i*); *induplicate* (*k*, *l*); *equitant* (*m*); *half-equitant* or *obvolute* (*n*).

In some plants with a shortened axis, the lateral buds produce long branches. Such are the *runners* of the strawberry.

A leaf bud may be *subterranean* as well as *aerial*. Some plants, as asparagus, with a perennial subterranean stem, have this terminated by a bud, which, elongating, makes its appearance above the ground, and finally developes aerial branches, leaves, and flowers. The young shoot of this character is called a *turio*. The potatoe is a thickened stem with leaf buds which may develope both aerial and subterranean branches: the former decay annually; the latter, as *tubers*, remain in the soil. A bulb is a subterranean bud. A *corm* (see p. 11) is an elongated bud with the scales reduced to thin membranes. Bulbs and corms contain a supply of starch and other matters for the sustenance of the young plant.

2. Organs of Reproduction.

The reproductive organs are to be found in the flower, the most important parts of which are the stamens and pistils. When these organs are conspicuous and definite, the plant is called *phanerogamous;* when they are concealed or unconspicuous, *cryptogamous*. Exogens and endogens belong to the former, acrogens and thallogens to the latter. The flower, however, in all its parts, is to be considered only as modified leaves.

The arrangement of the flowers in the axis is known as *inflorescence* or *anthotaxis*. The anatomical distinction between the leaf and the flower bud has already been referred to. The flower bud, like the leaf bud, is produced in the angle of leaves, here called *bracts* or *floral leaves*. The general axis along which the flowers or their buds are arranged is called the *rachis;* the stalk supporting a flower is the *peduncle;* peduncles lateral or secondary to this are called *pedicels*. A flower provided with a stalk is *pedunculate* or *pedicellate;* if without one, *sessile*. A more philosophical distinction is into *primary floral axis* (rachis), *secondary axis* (peduncles), *tertiary axis* (pedicels), &c.

The *peduncle* is variously formed, experiencing greater modifications than the petiole. Sometimes the axis is shortened, so as to exhibit a flattened form, with flowers scattered over the surface. Here it becomes a *receptacle*, *phoranthium*, or *climanthium*. Sometimes the peduncle is abortive, and becomes converted into a tendril; at others, it is expanded and hollowed out at the apex. The extremity of the peduncle is the *thalamas*, or *torus*.

Inflorescence is of two kinds; one where the lower flowers on the stem are produced first, the other where they are last to appear. In the first kind of inflorescence, called *indefinite*, or *axillary*, the axis continues to grow and to develope new leaf buds, the upper being always less advanced than the lower; or, if the axis be shortened, so that the peduncles stand crowded together, the central flowers are less advanced than the external. The expansion of the flower is thus *centripetal*.

The simplest form of indefinite inflorescence is, where single flowers are produced in the axils of the ordinary leaves. The different subdivisions and their relative lengths give rise to a great variety of terms. When the primary peduncle is elongated, and gives off nearly equal pedicels, each bearing a flower, we have a *raceme*, as in the currant, and a *panicle* when the pedicels of the raceme are themselves branched. If the central peduncles of a dense panicle are longest, a *thyrse* is produced. A *corymb* is where the lower pedicels on a peduncle are elongated, so that all the flowers on the different pedicels are nearly in one plane; the corymb may be *simple* or *compound*, the secondary axis again subdividing in the latter case. When the pedicels are very short or absent, so as to render the flowers sessile, a *spike* is produced: this, when producing unsexual flowers, as in the willow, becomes an *amentum*, or *catkin*. It may also be succulent or pulpy, with the flowers invested by a sheathing bract or *spathe*, as in Arum; it is then called a *spadix*. A *spike* bearing female flowers only, and covered with scales, is either a *strobilus*, as in the hop, or a *cone*, as in the pine.

When the primary axis is depressed, instead of being elongated, other forms are exhibited. Should the pedicels all spring from nearly the same point on the axis, we have an *umbel;* when numerous flowers are placed on a nearly flat receptacle, and either sessile or nearly so, a *capitulum*, *anthodium*, or *calathium* is formed, as in the dandelion; when the surface is more convex this is called a *glomerule*. A receptacle may be concave, and inclose the flowers, as it were; such an arrangement is called a *hypanteodium*, and is seen in the fig.

In *definite* inflorescence, where the flower buds are all terminal, the main axis is first terminated by a blossom which terminates its growth. This gives a solitary terminal flower, as in the Tulip. Further development can take place only by the production of axillary branches, which can spring from the primary peduncle only when it is furnished with bracts, from whose axils they may arise. The order of flowering is therefore from the apex downwards, or *descending* (the reverse of the indefinite forms); *centrifugal*, or from the centre outwards, if the blossoms are on a level

centrifugally. The simplest form is that of a single terminal flower. We may suppose a leaf to be developed on each side of the flower, in each of whose axils a new bud is produced, which, in turn, may each form the centre of a tertiary development, &c. Each flower may be the centre of a system of three or more instead of two. If we suppose the leaves above-mentioned to be reduced to bracts, the whole forms a single inflorescence, called a *cyme*, this being called dichotomous or trichotomous, according to the character of the subdivisions. Occasionally, in *dichotomous* divisions, the flowers are developed on one side only, from which results a peculiar curvature of the cyme, which is here called *helicoidal*, or *gyrate.*

As already remarked, the flower, except when terminal, always arises in the axil of a leaf, called the *bract.* Leaves which arise along the floral axis are called *bracteoles*, or *bractlets.* The true bract may be variously modified as to color, shape, &c. At the base of the general umbel, in umbelliferous plants, there is a whorl of bracts, termed the *general involucre*, that at the base of the smaller umbels being called the *partial involucre* or *involucel.* The cup of the acorn is produced by the union of many whorls of bracts. A sheathing bract inclosing one or more flowers is called a *spathe.* The outer sterile bracts in grasses are called *glumes.*

b. The Flower and its Appendages.

The *flower* consists of whorled leaves placed on an axis, the internodes of which are not developed. This shortened axis is the *thalamus*, or *torus.* There are usually four of such whorls: first, an outer one called the *calyx;* next, the *corolla;* then, the *stamens;* and innermost of all, the *pistil* or *pistils.* Each of these whorls consists, normally, of several parts. The plant is called *dichlamydeous*, when the two outer whorls or the floral envelopes are present; *monochlamydeous*, when one only exists; *achlamydeous*, when neither is present. In most instances the calyx and corolla, when present, are readily detected; in cases of doubt as to the true character of the envelope, or when there is no convenient distinction between the two, the term *perianth*, or *perigone*, may be employed. Should but one envelope be present, it is always the calyx.

The manner in which the floral envelopes are folded together is known as the *æstivation*, or *præfloration.* This is *valvate*, when the elements are so arranged as to constitute a circle without the overlapping of the edges. Should the edges of the parts be turned outwards, the æstivation is *reduplicate;* if inwards, *induplicate.* When each part of the whorl overlaps the one next to it on one side, and is in turn overlapped by the part on the other side, the æstivation is *twisted* or *contorted.* Sometimes the elements of the whorls, instead of being nearly in the same plane, stand at different heights, causing an *imbricated* æstivation. Should the parts envelope each other completely, a *convolute* æstivation is produced. *Vexillary* æstivation is where one part, the vexillum of a *papilionaceous* flower, envelopes all the

rest; *carinary*, where the carina performs a similar office. Calyx and corolla sometimes exhibit different æstivation.

The CALYX is the external envelope of the flower, and consists of whorled leaves, called *sepals*. These may either be separate, forming a *polysepalous* calyx, or united, to constitute a *gamosepalous*, or *monosepalous* calyx. The sepals are usually green, sometimes colored, rarely stalked; in shape, they are generally oval or oblong. As to direction, they are *erect*, *reflexed*, *patulous*, or *divergent* (spreading outwards), and *connivent* or arched inwards. A *trisepalous* calyx has three divisions: a *pentasepalous*, five, &c.

In a gamosepalous calyx the degrees of adhesion between the elementary parts may vary from very slight to complete. The divisions may be simple teeth, or they may extend as fissures towards the base. A *trifid* calyx is one in which three parts are united by about the lower half of the margins; a *tripartite* is one where only the lower part of the edges is so united. The calyx may also be quadrifid, quadripartite, quinquifid, quinquepartite, &c. The adhesion is sometimes irregular, some parts uniting to a greater extent than others; in this manner may be formed a two-lipped or *labiate* calyx, which becomes *ringent* when the upper lip is arched. The part formed by the union of the sepals is called the *tube;* the free upper portion, the *limb*.

Occasionally a flower is provided with a double calyx, the outer of which is called *epicalyx*, or *calicle*. The calyx, again, may degenerate, so as to become dry, scaly, and glumaceous; or it may be *obsolete* or *marginate*, existing only as a mere rim. In some families, as Dipsaceæ, the tube of the calyx adheres to the pistil, and the limb is developed in the form of hairs, called *pappus*. The pappus is either simple (*pilose*) or feathery (*plumose*). When the calyx falls off before the flower expands, it is *caducous;* or if the corolla accompany it, *deciduous*. Sometimes the tube of the calyx is united to the pistil, and enlarges with it to form part of the fruit, as in the apple. A persistent calyx, which increases after flowering, is called *accrescent;* it may, again, remain withered or *marcescent*, or become *inflated* or vesicular.

COROLLA. The corolla is that more or less colored inner floral envelope between the calyx and the stamens. The free subdivisions, which are generally disposed in one or more whorls, are called *petals*. A petal frequently exhibits two parts; a *claw* or *unguis*, a narrowed part by which attachment is made to the axis, and a broad expanded portion above this, called the *lamina*, or *limb*. When there is no claw the petal is sessile.

Petals, in their modifications, exhibit a considerable resemblance to ordinary leaves, in having the margin either entire or indented. A single petal may be bipartite or bifid, &c. When a petal is folded like a boat, it is *cymbiform* or *navicular; cochleariform*, when resembling the bowl of a spoon. When a petal is prolonged backwards, in the form of a spur, it is *calcarate*. When the spur is very short and rounded the petal is *gibbous*.

When but a single petal is present, the rest being abortive, the flower is *unipetalous;* two, three, four, five, &c., petals constitute a di-, tri-, tetra-, or

penta-petalous corolla. A corolla, with more than one separate petal, is known generally as *polypetalous;* it is *gamopetalous* or *monopetalous* when the petals are united. The adhesion extends, in greater or less degree, from the base to the apex. When the petals are similar and equal in size, the corolla is regular; otherwise, *irregular.* In monopetalous corollæ, the claws or inferior parts of the petals are usually united into a tube, crowned by the limb, as in the calyx; the two portions are separated by the *throat.*

In REGULAR POLYPETALOUS corollas we have the *rosaceous,* with five spreading petals, without claws, and arranged as in the strawberry; the *caryophyllaceous,* with five petals, with long, narrow, tapering claws, as in the pink; the *alsinaceous,* where the claws are broader, with distinct spaces between the petals; *cruciform,* having four, often unguiculate petals, placed opposite to each other, as in a cross (seen in the Cruciferæ).

Among IRREGULAR POLYPETALOUS corollas the most striking is the *papilionaceous,* usually with five petals, one superior (or posterior) and larger than the rest, called the *vexillum;* two lateral, called *alæ;* and two inferior (or anterior), partly or entirely covered by the alæ; often united into a single piece, called the *carina,* or keel.

REGULAR GAMOPETALOUS COROLLAS. These are *campanulate,* or bell-shaped; *infundibuliform,* or funnel-shaped; *hypocrateriform,* or salver-shaped, where there is a straight tube, surmounted by a flat spreading limb; *tubular,* with a long cylindrical tube, apparently continuous with the limb; *rotate,* where the tube is very short, and the limb spreading.

IRREGULAR GAMOPETALOUS COROLLAS. Conspicuous among these is the *labiate* corolla, having two divisions of the limb, in the form of labia or lips, the upper lip usually composed of two pieces, the lower of three, and separated by a hiatus. The parts of the calyx follow the reverse order. When the upper lip of a *labiate* corolla is much arched, and the lips separated by a distinct gap, it is called *ringent.* When the lower lip is pressed against the upper, so as to leave a mere rictus between them, the corolla is *personate* or masked; the projecting portion of the lower lip is called the *palate.* When a tubular corolla is split up, so as to form a strap-like process on one side, with several tooth-like projections at the apex, it becomes *ligulate,* or *strap-shaped.*

What are sometimes called *nectaries* in flowers, are most generally mere modifications of the corolla or stamens. Sometimes they are constituted by the separation of a layer from the inner side of a petal, which may be known by their being opposite to the segments of the latter. This process is called *unlining,* or *deduplication.*

The calyx and corolla, as just considered, constitute merely the external envelopes of the flower, and may be absent without vitiating the fertility of the plant. The *essential* organs of reproduction are the *stamens* and the *pistil.* The latter, as the female organ, includes the ovary in which the seeds are to be produced, while the former, supplying the functions of a male, furnish a seminal matter to fertilize the ovules of the pistil. The production of a perfect and reproducing seed requires that both be present.

When both organs are found in the same flower, this is *hermaphrodite;* it is *unisexual*, or *diclinous*, if but one of the two be present. A flower bearing stamens alone, is *staminiferous;* and *pistilliferous*, when only the pistil is present. The absence of one of the organs is due to *abortion* or *non-development.* When the same plant, with unisexual flowers, embraces both kinds, it is *monœcious;* if the two sets of organs are borne on different individuals, the species is *diœcious.*

The stamens which arise within the petals and in one or more whorls on the thalamus, constitute, when taken together, the *androecium* or male apparatus. Their normal position is below the whorl on the pistil; they are then *hypogynous*, and without adhesion to the walls of the calyx. When united to the petals, they are *epipetalous.* If attached to the sides of the calyx, they become *perigynous;* and if united both with the surface of the calyx and of the ovary, they are *epigynous.* These are important terms in classification. Plants bear the general title of *thalamifloræ* when the parts of the corolla and androecium are independent of each other, and all the whorls inserted directly upon the torus. They are *calycifloræ* when the petals are separate, and the stamens inserted directly on the calyx: *corollifloræ* when the united petals bear the stamens.

The number of stamens varies from one to many hundreds, arranged in a variable number of whorls. When there is but one whorl, the stamens are usually equal in number to the sepals or petals, and are arranged opposite to the former, and alternate with the latter; the flower is then *isostemonous.* When the stamens are unequal in number to the sepals or petals, the flower is *anisostemonous.* When there are twice as many stamens as sepals or petals, the flower is *diplostemonous;* if more than this, *polystemonous.* The number of stamens is generally an exact multiple of the number of floral envelopes. By an arrest of development in which the number of stamens is less than that of sepals or petals, the flower is *meiostemonous.*

When the number of stamens is less than 20, they are called *definite*, and the flower is *oligandrous;* over this number they are *indefinite* or *polyandrous*, and are marked 00. The number of definite stamens is indicated by prefixing the Greek numeral to *androus;* thus a flower with one stamen is *monandrous;* with two, *diandrous;* three, *triandrous;* four, *tetandrous;* five, *pentandrous;* six, *hexandrous;* seven, *heptandrous;* eight, *octandrous;* nine, *enneandrous;* ten, *decandrous*, &c.

A stamen consists of two parts, one contracted and thread-like, answering to the petiole of the leaf, and called the *filament;* the other, a broader portion, representing the blade of the leaf, and called the *anther*, which contains a powdery matter termed *pollen.* The anther is the essential male organ. When there is no filament, the anther is *sessile.* The filament may vary much from its usual thread-like form. It sometimes puts on a *petaloid* appearance; is occasionally *subulate* or awl-shaped, and again, *clavate* or club-shaped. When the filament is bent or jointed it is *geniculate.* Certain appendages are sometimes seen at the bases of filaments which are then said to be *appendiculate* or *strumose.* The filaments occasionally

adhere to a greater or less extent; sometimes this takes between an entire whorl, so as to form a tube; the stamens are then *monadelphous*. They are *diadelphous* when forming two bundles, *triadelphous* when united into three, and *polyadelphous* when grouped into a greater number. Filaments are sometimes united with the pistil to form a *columna* or column, as in Asclepias. The column is called *gynostemium*, and the flowers are said to be *gynandrous*.

The ANTHER corresponds to the blade of the leaf, and consists of lobes with cavities inclosing a fine powder called *pollen*, which, when mature, is discharged by an aperture. The covering of the anther is double; the outer is called *exothecium*, the inner *endothecium*. The anther usually possesses two lobes, corresponding to the two halves of the leaf; in each lobe there are generally two cavities separated by the *septum*. The *connective* divides the two lobes. An anther with four persistent cavities is called *quadrilocular* or *tetrathecal*. When, as is more generally the case, the septa are absorbed, the anther becomes *bilocular* or *dithecal*. Sometimes there is but one cavity, constituting the *unilocular* or *monothecal* anther. The form of the anther lobes varies much in different plants; more usually they are oval or elliptical. The part of the anther to which the filament is attached is called the *back*, the opposite being the *face*. The division between the lobes is marked on the face of the anther by a groove or *furrow*, and on the face there is usually a *suture*, along which the pollen is discharged. When the filament appears to be continued along the back of the anther, this is *adnate* or *adherent; innate* or *erect* when it ends at the base. A *versatile* anther is one which is not fixed immovably to the filament. Sometimes the connective is more or less horizontal, and bears a lobe of the anther at each end; it is then said to be *distractile*. The opening of anthers to discharge the pollen is their *dehiscence*. This may be either *longitudinal* or *transverse*. In *circumscissile dehiscence*, the entire apex of the anther comes off to permit the escape of the pollen. An anther is *introrse* when it opens on the surface next to the centre of the flower, and *extrorse* when the contrary takes place. A stamen sometimes degenerates and becomes sterile from the absence of a proper anther; such are called *staminodia*, and may present various appearances, as scales, leaves, petals, &c.

We have already referred to the adhesion of the filaments of the stamen leaving the anthers free. These in turn may be attached without involving any connexion between the filaments. In this case the flower is said to be *syngenesious* or *synantherous*. Stamens whose length does not exceed that of the tube of the carolla are said to be *included;* they are *exserted* when of greater length.

Although the stamens are usually of the same length, yet it often happens that one or more is longer than the rest. Flowers are *didynamous* when, of four stamens, two are long and two are short. When there are two pairs of long stamens separated by a pair of shorter, the flower is *tetradynamous*. A stamen is said to be *declinate* when it bends to one side.

POLLEN, or the powdery matter discharged from the anther, consists of small independent cells which have been developed in the anther by the

fissiparous division of an original cell called the *pollen utricle.* The pollen grains fall out either singly or united in definite number: sometimes the entire mass is combined by viscid matter into conglomerations called *pollinia.* Such is the case in Orchidaceæ; here each mass has a prolongation or stalk called a *caudicle*, which sometimes adheres to a prolongation at the base of the anther called *rostellum*, by means of a viscid matter termed *retinaculum.* The part of the column in Orchids where the stamens are situated, is sometimes termed *clinandrium.*

The mature pollen grain has an external covering called *extine*, and one internal, *intine.* Within these coverings is contained a granular semifluid matter termed *fovilla*, and composed of small spherical granules sometimes $\frac{1}{30000}$ of an inch in diameter, together with larger corpuscules which are said to exhibit apparently spontaneous movements. The pollen grains themselves vary from $\frac{1}{300}$ to $\frac{1}{700}$ of an inch in diameter, and exhibit highly diversified forms. This form is much altered by the application of moisture. This, when applied to one side, causes the intine to project outwards and form what is called a *pollen tube.*

Cryptogamic plants exhibit certain organs, supposed by some to represent stamens, and known as *antheridia* or *pollinaria.* These are closed sacs, developed in various parts of the plant, either at the surface or concealed in its tissue. The contents of antheridia consist of utricles inclosing peculiar bodies which have been termed *phytozoa*, and exhibit active movements at certain periods of existence, when they have been taken for infusorial animalcula.

The Disk. By this term is to be understood whatever intervenes between the stamens and the pistil. The forms under which it is presented are those of hairs, scales, glands, &c., often containing saccharine matter, and forming a so-called nectary. The disk may be formed by the degeneration and transformation of the stamens.

The Pistil occupies the centre of the flower, being surrounded by the stamens and floral envelopes. It constitutes the innermost whorl, and is the female organ of the plant, which, after flowering, is changed into the fruit, and contains the seeds. Sometimes it is called the *gynæcium.* It consists essentially of two parts, the *ovary* or *germen*, and the *stigma*, which is either *sessile* (seated immediately upon the ovary) or elevated on a stalk called the *style.* The pistil, like the other organs, consists of one or more modified leaves called carpels. A pistil consisting of a single carpel is *simple;* otherwise, *compound.* Each carpel has its special ovary, style (when present), and stigma, and is formed by a folded leaf whose upper surface is turned inwards towards the axis, the lower outwards; one or more buds called *ovules* being developed at the margin. The *ovary* then represents the limb or lamina of the leaf. The *style* is generally cylindrical in form, and is traversed by a narrow canal, in which there are some loose projecting cells forming the *conducting tissue*, as also elongated tubes at the period of fecundation. The *stigma* is a continuation of the cellular tissue in the centre of the style, and may be either terminal or lateral; in the Orchidaceæ it is placed on a part of the column called the

gynizus. The individual carpels composing a pistil may be arranged like leaves, either in a whorl, or along a spiral. When they remain separate and distinct, the pistil is *apocarpous;* when the carpels are all united, the pistil is *syncarpous;* when the union of the carpels takes place by the ovaries alone, leaving the styles and stigmas free, the pistil is *gamogastrous*, and the ovary *compound*. The number of parts in a syncarpous pistil may be determined by the external venation, the grooves on the outside, and the internal divisions of the ovary. When the grooves between the carpels are deep, the ovary is said to be *lobed*. The carpels, although generally sessile, are sometimes petioled and elevated above the surrounding whorls. The union of these petioles constitutes a *stipitate* pistil; or when thickened and somewhat succulent, a *gynophore*, or *thecaphore;* when the axis is produced beyond the ovaries, and the styles are united to it, we have a *carpophore*.

The ovules are developed on the inner side of the carpel, where the two edges of the carpellary leaf unite. The attachment to the edge, according to some authors, but doubted by others, is effected by vascular tissue, which traverses the carpel and sends off a branch to each ovule. At the same place there is a development of cellular tissue connected with the conducting tissue of the style and with the stigma. The union of these two tissues constitutes the *placenta* or projection to which the ovules are attached; those who restrict this term to the individual branch of each ovule, style it the *placentary*, or the *pistillary cord*. The placenta marks the *ventral* or *inner suture* of the carpel, the *outer* or *dorsal* suture corresponding to the midrib of the carpellary leaf. The placenta is formed on each margin or edge of the carpel, and hence it is essentially double, although sometimes appearing single; in an apocarpous pistil there are generally separate placentas on each margin. In the syncarpous, however, the edges of contiguous carpels unite to form a *septum* or *dissepiment*. When the dissepiments extend to the centre or axis, the ovary is divided into cavities, *cells*, or *loculaments;* it may be bilocular, trilocular, quadrilocular, &c., as there are two, three, four, or more cells corresponding to as many carpels. In these cases the marginal placentas meet in the axis, and unite so as to form a central one. This kind of placentation is, perhaps improperly, termed axile. When the dissepiments do not extend to the centre, but merely form a projecting partition, the ovary is *unilocular*, and the placentæ *parietal*. Sometimes the placentæ are not connected with the walls of the ovary, but form a column, standing free in the centre; in this case we have a *free central placenta*. In some rare cases the phenomena of placentation are such as to lead us to suppose that the placentæ are not marginal, or on the edges of the carpellary leaves, but rather *axile*, that is, prolongations of the axis, the ovules being lateral buds, and the carpels verticillate leaves united together around the axis.

Divisions in ovaries, not formed by the edges of contiguous carpels, are called *spurious dissepiments*. These, when horizontal, are termed *phragmata*. The prolongation of the edges of the placentæ in a *replum* sometimes subdivides the ovary.

The ovary may be either free in the centre of the flower, or it may be adherent, especially to the calyx. When this is united throughout it becomes *superior*, the ovary itself being *inferior*. When the union takes place but in part, the ovary is *half inferior*, and the calyx *half superior*.

The STYLE, which proceeds from the summit of the carpel, may be considered as the upward prolongation of this, and hence called *apicilar*. The carpellary leaf may be so folded that the style appears to proceed from the side of the ovary; in this case it is *lateral*, and *basilar* when proceeding from the base. When the ovaries are grouped around a central prolongation of the torus, continuous with a united columnar style, the arrangement is termed a *gynobase*. The style, although usually smooth, may be coated with hairs, termed *collecting hairs*, which aid in distributing the pollen. When the styles of a syncarpous pistil are united completely into a single one, this is said to be *simple;* when the union is only partial, the style is *bifid*, *trifid*, &c.; and *bipartite*, *tripartite*, &c., when the union extends but a short distance above the apex of the ovary. A style which falls off after fertilization is said to be *deciduous*, otherwise it is *persistent*.

The STIGMA terminates the style, and is usually in direct communication with the placenta. Its position may be either terminal or lateral. It consists of loose cellular tissue, and secretes a viscid matter which retains the pollen, and causes it to protrude tubes. A stigma which is divided by one or more grooves may be *bilobed*, *trilobed*, &c., or *bilamellar*, *trilamellar*, &c., according as the partial divisions are rounded or flattened. The form of the stigma varies considerably.

In CRYPTOGAMOUS PLANTS there are organs termed *pistillidia*, supposed to perform the functions of pistils, which consist of hollow cavities, termed *sporangia*, or *thecæ*, and containing the equivalents of ovules termed *spores*. The sporangia may be immersed in the body of the plant, or supported on stalks, termed *setæ*.

The OVULE is attached to the placenta, and is destined to produce the future plant. Although usually embraced within an ovary, in some cases it has no proper covering, then called *naked*. A partial inclosing by the carpellary leaves renders the ovules *seminude*. The ovule may be attached to the placenta, either directly, when it is sessile, or by the intervention of a prolongation of the latter, termed *funiculus*, *umbilical cord*, or *podosperm*. The placenta is sometimes called the *trophosperm*. The part by which the ovule is attached to the placenta is known as the *base* or *hilum*, the opposite extremity being the *apex*. The ovule consists of a cellular mass, termed the *nucleus*, inclosing a cavity in which the embryo is suspended by a thread-like cellular process, called *suspensor*, and attached to the summit of the nucleus. In some cases the cavity is lined by an *epithelial* membrane, which constitutes the *embryo-sac*, containing the *amnios*, a mucilaginous fluid in which the embryo forms. The nucleus itself may be either naked or enveloped in one or two coverings; when two are present the outer is called *primine*, the inner, *secundine*. These integuments leave an opening at the apex of the nucleus composed of two apertures; the one in the primine, called *exostome*, the other in the secundine, termed *endostome*.

The foramen of the ovule is also called *micropyle.* The nucleus and integument are united at the base of the ovule by a cellulo-vascular membrane, called *chalaza.* The hilum indicates the organic base of the ovule, the foramen marking the apex. The primine, secundine, and nucleus, are always united together at some point of their surface. When this union takes place at the base of the ovule, as in its embryonic condition, this is said to be *orthotropal*, or *atropal.* When the ovule is curved downwards, so as to approach the placenta, it is *camptotropal;* when curved downwards, and grown to the lower half, *anatropal;* when attached by the middle, so that the foramen is at one end, and the base at the other, it is *campylotropal*, or *amphitropal;* when shaped like a horse-shoe, *lycotropal;* when anatropal, with the *raphe* half loose, *semianatropal.* By *raphe* is meant the vascular connexion between the base of the ovule and the base of the nucleus, in cases where these two bases do not coincide as they do in the orthotropal ovules.

An ovule is said to be *ascending* when attached to a parietal placenta. with the apex directed upwards. It may hang from an apicilar placenta at the summit of the ovary, and be *inverted* or *pendulous;* or it may be *suspended* from a parietal placenta near the summit. When two ovules in the same cell are placed side by side, they are *collateral*, and their relative positions may otherwise vary.

c. *Fertilization.*

The fertilization of a flower usually results from the action of pollen upon the stigma, which in some manner causes the development of an embryo within the nucleus. Authors disagree as to the precise manner in which this action is exerted. The theory most generally adopted is, that the pollen grains falling on the stigma are detained there, and soon exhibit a protrusion of the inner coat, or intine, in the shape of a tube, which penetrates the stigmas, and passes down through the style, ultimately to reach the embryo. The result of this action is the formation of a vital point (a single cell), which ultimately becomes the embryo, and from which a new plant may be produced by exposure to the proper conditions. Sometimes more than one embryo may be developed in the same ovule. The embryo derives the material of its growth from the surrounding tissues, and the whole series of phenomena is attended by the evolution of heat, which sometimes is quite conspicuous. Authorities disagree as to whether or not the germinal vesicle exists in the embryo-sac before the application of the fovilla. In some cryptogamous plants the vital spores are discharged from their envelope without any apparent union of cells of two different sexual characters: in the Confervæ and Diatomaceæ, however, there is a union of the contents of two different cells, by means of tubes, which are protruded from one into the other. This process, called *conjugation*, results in the production of germinating bodies. When the pollen of one species of plant fertilizes the ovule of another species, the result is a *hybrid.* These, however, are of rare occurrence in nature.

d. The Fruit.

Various changes occur in the flower after fertilization, the principal of which consist in the enlargement of the ovary, which becomes the *pericarp*, and within this the development of the ovules into *seeds* containing the *embryo*. The other portions of the flower generally dry up and fall off, although some may be persistent. The term *fruit*, in all strictness, only applies to the mature ovary, with its contents; although it sometimes includes other parts, as the bracts and floral envelopes. The anatomy of the fruit much resembles that of the ovary. The pericarp usually consists of three layers: the external or *epicarp*, the middle or *mesocarp*, and the internal or *endocarp*. In such fruits as the peach the mesocarp becomes much developed, forming the fleshy pulp, and hence called *sarcocarp;* while the endocarp, thickened by woody matter, constitutes the *putamen*, or *stone*. The part of the pericarp attached to the peduncle is termed the *base*, that where the style or stigma existed being the *apex*. When the style remains in a hardened form the fruit is *apiculate*. As in the carpel, so in the ripe fruit, the ventral suture consists of the edges united towards the axis, the dorsal suture corresponding to the midrib. When the sutures are united so firmly as not to give way when the fruit is ripe, this is said to be *indehiscent; dehiscent*, when either suture opens. Indehiscent fruits are either dry, as in the nut, or fleshy, as in the cherry and apple. When the pericarp is closely incorporated with the seed the fruit is *pseudo-spermous*. When fruits, composed of single carpels, open only by the sutures, the dehiscence is said to be *sutural;* when composed of several carpels, the valves may separate through the dissepiments, and give rise to a *septicidal* dehiscence. When the valves separate, so as to leave the placentæ in the centre, these may form a single column, called *columella*. When dehiscence takes place along the dorsal sutures, and the separating valves carry the septa with them, the dehiscence is *loculicidal;* it is *septifragal* when the septa separate from the valves, and remain attached to the centre. The separation of the valves may take place from above downwards, or the reverse. In Umbelliferæ the two carpels separate from the lower part of the axis, but remain attached to a prolongation of it, called a *carpophore*, or *podocarp*. In the Siliqua, or fruit of the Cruciferæ, the valves separate from the base, leaving a central *replum*.

Fruits may also open transversely, the dehiscence, in this case, being *circumscissile*. Dehiscence, again, may be effected by partial openings in the pericarp, called *pores*, which may be variously situated.

Fruits may be formed by one flower, or by several combined. In the former case they are either *apocarpous*, with one mature carpel, or *dialycarpous*, with several separate free carpels. In the latter case they are said to be *syncarpous*. An *anthocarpous* or *multiple* fruit is formed when the bracts and floral envelopes are combined with the ovaries of a syncarpous fruit.

Apocarpous fruits, then, are formed of one or several free carpels, and may

be either dry or succulent, according as the pericarp remains more or less foliaceous in structure, or becomes fleshy or pulpy. Fruits which open when ripe to discharge the seeds are *dehiscent;* otherwise they are *indehiscent.* An indehiscent apocarpous fruit may contain but one seed, and is then *monospermous.* The *achænium* is a dry monospermous fruit, the pericarp of which is closely applied to the fruit, but separable from it. It may be *solitary* (single) or *aggregate* (several achænia placed on a common receptacle). The aggregate achænia of the rose are known as the *cynarrhodum.* Achænia are *caudate* when the styles remain attached. The fruit of Compositæ, sometimes called *cypsela,* is an achænium united to the tube of the calyx. When the pericarp is thin, and surrounds the seed like a bladder, the achænium becomes a *utricle.* When the pericarp is extended in the form of a winged appendage, the achænium becomes a *samara.* When the pericarp is inseparably united with the seed the fruit becomes a *caryopsis.* The *nut* is a one-celled fruit, with a hardened pericarp, surrounded by bracts at the base, as on the hazelnut, which, besides, is enveloped by leafy appendages, forming the husk or hull. The *drupe* is a succulent fruit, the pericarp consisting of epicarp, mesocarp, and endocarp, and when mature containing a single seed, as in the peach.

Dehiscent Apocarpous fruits may consist either of a few seeds only (*oligospermous*), or the seeds may be numerous (*polyspermous*). The first fruit to be mentioned under this head is the *follicle,* which is a mature carpel, containing several seeds, and opening by the ventral suture. The *legume,* or *pod,* is a solitary, simple carpel, dehiscing by the ventral and dorsal suture, the seeds being borne on the former. Sometimes the legume is contracted at intervals, including each seed in a separate cell, which separates from its neighbor when ripe. This constitutes the *lomentum.*

Indehiscent Syncarpous Fruits. The berry (bacca) is a succulent fruit, in which the seeds are immersed in a pulpy mass, formed by the placentas, as in the gooseberry. The *pepo,* or *peponida,* as in the pumpkin or melon, is composed of about three carpels, forming a three-celled indehiscent fruit with parietal placentæ. The *hesperidium,* seen in the orange, is a berry having a pericarp separable into an epicarp, an endocarp, and a sarcocarp, the endocarp sending prolongations inwards, forming triangular divisions in which pulpy cells are developed, so as to surround the seeds. The *balausta* has the seeds arranged irregularly on the backs of the cells, with the carpels inclosed within a tough rind. The *pome* is a fleshy fruit, with the calyx adherent, and in connexion with the epicarp and mesocarp, forming a thick cellular edible mass; the endocarp forms separate horny cells, inclosing the seeds; e. g. the apple.

Dehiscent Syncarpous Fruits. By *capsule* is meant all dry syncarpous fruits opening by valves or pores. When the capsule opens by a lid it is called a *pyxidium.* The *siliqua* consists of two carpels fastened together, the placentæ of which are parietal and separate from the valves, remaining in the form of a *replum,* and connected by a membraneous expansion. When the fruit is long and narrow, it is called a *siliqua;* when short and

broad, *silicula.* When the replum, which consists of two lamellæ, exhibits perforations, it is called *fenestrate.*

Multiple, or anthocarpous fruits, are those in which the floral envelopes, with the ovaries of several flowers, are united into one. Among these may be mentioned the *sorosis*, a multiple fruit, formed by an united spike of flowers which becomes succulent. Thus the pineapple is composed of numerous ovaries, floral envelopes, and bracts, united into one succulent mass. The *syconus* is an anthocarpous fruit, in which the axis or extremity of the peduncle is hollowed, so as to bear numerous flowers, as in the fig. The *strobilus* is a fruit-bearing spike, more or less elongated, covered with scales, each one representing separate flowers, with two seeds at the base. These scales may be thin and membraneous, as in the hop, or they may be thickened, as in the pine. In the juniper they become fleshy, and are so incorporated as to form a globular fruit, like a berry, sometimes termed a *galbulus.*

e. Of the Seed.

The seed is the fertilized ovule arrived at maturity by the development of the embryo. Seeds are usually contained in a seed vessel, or pericarp, and hence called *angiospermous;* some few, however, are without any pericarpal covering, or are *gymnospermous*, and when the covering is only partial the seed is *seminude.* Each seed consists of several distinct elements, like the ovule, being composed of *nucleus* and *integuments.* It is only rarely that all the membranes of the ovule are visible in the seed, the embryo-sac often becoming absorbed or incorporated with the cellular tissue of the nucleus. More usually the seed consists of the embryo and two coverings. The general covering of the seed is termed *spermoderm*, consisting of two parts, an external membrane, called *episperm*, or *testa*, and an internal membrane, the *endopleura.* When the secundine remains distinct in the seed, it forms the *mesoperm;* or when fleshy, the *sarcosperm*, or *sarcoderm.* When the embryo-sac remains distinct from the neuclus in the seeds, it forms a covering to which the name of *vitellus* has been given. Sometimes there is an additional covering to the seed, resulting from an expansion of the funiculus or placenta after fertilization, and covering the foramen, termed the *arillus;* when the expansion proceeds from the uncovered foramen, we have an *arillode*, as seen in the bright scarlet coverings of the seeds of Euonymus. Certain cellular bodies produced on the testa at various points, and in no way connected with fertilization, are known as *strophioles*, or *caruncles.* As in the ovule, the point where the funiculus is attached to the seed is termed the *hilum*, or *umbilicus.* The foramen of the ovule becomes the *micropyle* of the seed with the exostome and endostome; it is to this part that the root of the embryo is directed. A small process or valve which overlies the micropyle of the bean is termed *embryotega.* The vessels from the placenta, after passing through the funiculus, enter the seed either at a point of the hilum, called the

omphalode, or else pass under the external integument in the form of a *raphe* to the chalaza, when this is not coincident with the hilum. The terms, *orthotropal*, *campylotropal*, *anatropal*, *face*, *back*, &c., already explained under the head of the ovule, apply equally to the seed.

As the embryo increases in size, it causes an absorption of cellular matter from the embryo sac and nucleus, to such an extent as sometimes to reduce these to the condition of a thin integument, in which case the seed consists of embryo and integuments alone. A peculiar substance, termed *albumen*, is frequently formed around the embryo, which, when developed within the embryo-sac alone, is known as *endospermic albumen*, or *endosperm;* and when within the cells of the nucleus alone, *perispermic albumen*, or *perisperm*. Sometimes both kinds occur in the same seed: when the embryo occupies the whole seed, this is *exalbuminous; albuminous*, when there is a separate deposit of albumen. The object of the albumen is to supply food to the embryo at the period of germination. It varies much in its nature, being *farinaceous*, or *mealy*, consisting of starchy cells, as in the grains; *fleshy*, or *cartilaginous*, as in the cocoa-nut; and *horny*, as in some palms, and in coffee. When the cellular tissue combines with the albuminous matter so completely as to form but one substance, the albumen is *solid; ruminated*, when a portion of the tissue remains unconverted, causing a mottled appearance, as in the nutmeg. The albumen consists, chemically, of oily matter, starch, and nitrogenized compounds.

The embryo consists of *cotyledons*, or rudimentary leaves; the *plumule*, or *gemmule*, which represents the ascending axis; the *radicle*, or the germ of the descending axis; and the point of union of the two, or the *collum*. The part intervening between the collar and cotyledons is the *caulicule*, or *tigelle*. The embryo varies in its structure in different divisions of the vegetable kingdom. Thus, in acrogens and thallogens it continues to be a cell or spore, with granular matter in the interior, without any cotyledons; hence such plants are said to be acotyledonous. In endogens and exogens, on the other hand, there is a distinct separation of parts in the embryo, the former having, however, but one cotyledon (*monocotyledonous*), the latter two (*dicotyledonous*). In the spore of the acotyledonous plant germination takes place in any part of the surface. Sometimes spores are united in definite numbers by a cellular covering, called *perispore*, or *sporidium;* the *tetraspore* of the Algæ consists of four spores thus united.

The first part formed in the embryo is the *axis*, having one of its extremities turned towards the suspensor, and indicating the point whence the radicle is to proceed; the other end pointing in the opposite direction, and answering to the stem. From the point where the cotyledons are united to the axis a bud is developed (as from the axils of leaves); this contains the rudiments of the true or *primordial* leaves of the plant, and is known as the gemmule, or plumule. This bud may usually be seen lying within the cotyledons. In the monocotyledon the gemmule is usually inclosed by the mostly cylindrical cotyledon at its lower portion. The form of the dicotyledonous embryo varies considerably, but is always distinguishable from the monocotyledonous by a division at the cotyledonary

extremity. The cotyledons, however, are not always of the same size, and the union between the two may be so intimate as to give rise to the *pseudo-monocotyledonous* embryo. Sometimes there are more than two cotyledons, and plants in which this occurs are sometimes termed *polycotyledonous.* Cotyledons are usually entire and sessile. Sometimes, however, they become *lobed* as in the walnut, *petiolate*, or *auriculate.* Like leaves in the buds, cotyledons may be either applied directly to each other, or else folded in various ways, becoming *conduplicate*, *reclinate*, *convolute*, *circinate*, &c.

The radicle may be either straight or curved, the difference in this respect characterizing certain divisions of plants. Thus, in Cruciferæ the division Pleurorhizeæ exhibits the cotyledons applied by their faces, with the radicle folded along their edges, so as to be *lateral;* the cotyledons are then *accumbent.* In Notorhizæ the *dorsal* radicle is folded on the back of the *incumbent* cotyledons, these being applied to each other by their face. In Orthoploceæ the cotyledons are *conduplicate*, and the radicle included between their folds.

With respect to the perisperm, the embryo is *internal* or *intrarius* when inclosed by this on all sides, excepting the radicular extremity; when lying outside of the perisperm, and only coming in contact with it at certain points, the embryo is *external* or *extrarius.* When the embryo follows the direction of the axis of the seed, it is *axile* or *axial*, and may be either internal or external. When the embryo is not in the direction of the axis, it is *abaxial.* When, as in some campylotropous ovules, the embryo is curved and external to the perisperm, it is *peripherical.*

Although the radicle is usually turned towards the micropyle, and the cotyledons to the chalaza, yet the former may be directed to one side of the nucleus, and the embryo is then *excentric.* The position of the embryo in different seeds varies. In an orthotropal seed the embryo is *antitropal*, the radicle pointing to the apex of the seed; if the nucleus be inverted or antitropal, the embryo will be erect or *orthotropal.* In curved seeds the embryo is folded, so that the extremities are approximated, hence called *amphitropal.*

When a seed begins to germinate, the embryo first lengthens its radicle, then its caulicle, and afterwards sends the plumule upwards, in the form of a stem and leaves. The radicle extends downwards, either directly from the base of the embryo, or after having previously ruptured the integument of the base. Plants with the first character are said to be *exorhizal;* with the second, *endorhizal.* The former is most common in dicotyledons; the latter, in monocotyledons. In most plants the cotyledons are gradually raised to the surface by the growth of the caulicle, after which they become green and act as leaves; sometimes, however, the cotyledons remain inclosed within the testa.

f. Reproductive Organs of Flowerless Plants.

We have already adverted in brief terms to many of the peculiarities of

the reproductive organs of cryptogamous plants, and now propose to combine these under one general head, with the addition of some points hitherto omitted. In the case o FERNS, reproduction is effected by means of *spores*, inclosed in cases named *thecæ*, which often form in clusters or *sori* on the under side of the leaves, or beneath the epidermis. This latter, when including the thecæ, is called the *indusium*. The thecæ, or spore cases, have frequently a stalk passing up one side, and disappearing on the other; the point where this is attached is called the *annulus*.

URN MOSSES are increased by spores contained within an *urn*, placed at the apex of a seta or stalk, bearing on the summit a loose hood, called a *calyptra*, and closed by a lid or *operculum*. At the base of the spore case is sometimes found a tumor or *struma*, or an equal expansion, termed *apophysis*. The inside of the thecæ has a central axis, or *columella*; and the orifice beneath the operculum is closed by teeth-like processes, or a membrane called *peristome*.

LICHENS are cellular expansions, consisting of a *thallus*, or combination of stems and leaves, upon which appear *shields* or *apothecia*. These are the reproductive organs, and consist of a margin inclosing a kernel or *nucleus*, in which are imbedded tubes containing sporules, and termed *asci*.

In the highest forms of FUNGALS there are two kinds of organs: one, *cystidia*, conical naked elevations; the other, *basidia*, also conical elevations, but bearing spores on their apex.

GENERAL CONSIDERATIONS WITH RESPECT TO PLANTS.

A. THE CHEMICAL CONSTITUENTS OF PLANTS.

Plants are composed of certain chemical elements, which are combined in various ways, so as to form either *organic* or *inorganic* compounds. The former are composed of carbon, oxygen, hydrogen, and nitrogen, with a certain proportion of sulphur, or phosphorus; the latter consist of various metallic bases, combined with metalloids and acids. Water is a chief constituent of plants, the amount being determinable with approximate accuracy, by drying the plant at a heat slightly exceeding that of boiling water, and estimating the loss of weight. When the plant is burned the organic constituents disappear, and the inorganic are left in the form of binary or ternary compounds.

CARBON is the most abundant constituent of the plant, forming a greater proportion of its mass than any other. When vegetable matter is heated without exposure to air, the carbon is left in the form of charcoal, of a black color and porous texture, retaining much of the original volume and shape. It exists in great quantity in the soil, but requires to be converted into carbonic acid before it can be taken up by the plant. Most of the carbon of the plant is derived from the decomposition of the carbonic acid of the

atmosphere by means of the leaves. Thus the plant decomposes carbonic acid, assimilates the carbon, and liberates the oxygen; an animal, on the other hand, deprives the air of its oxygen, and liberates carbonic acid. OXYGEN is next in importance to carbon. It is usually found in combination with *hydrogen*, forming water. NITROGEN is less an universal constituent than the other, being chiefly found in the younger parts and the seeds. These four elements occur as binary compounds in water and oily matters; as ternary in starch, gum, sugar, and cellulose; and as quaternary in gluten, caseine, albumen, and fibrine. The latter compounds have for their base a substance known as proteine (C^{40}, H^{31}, N^5, O^{12}), with the addition of certain proportions of sulphur and phosphorus.

The principal inorganic constituents of plants are formed of combinations of chlorine, iodine, bromine, sulphur, phosphorus, potassium, sodium, calcium, magnesium, aluminum, silicon, iron, manganese, and copper.

SILICA abounds in grasses, giving firmness to the stem. It is sometimes found aggregated in the joints of the bamboo as tabasheer. LIME is found in all plants, in some existing in large quantity. It occurs as a carbonate on the surface of some plants. SODA and POTASH are also of constant occurrence. Plants growing near the sea exhibit a preponderance of soda, while those that are inland abound most in potash. IRON and MANGANESE are found in small quantity; COPPER has been detected in coffee.

B. PRODUCTS AND SECRETIONS OF PLANTS.

Having thus very briefly mentioned the principal elements found in plants, we proceed next to a summary of their most important compounds. The first to be mentioned is STARCH, which is stored up to serve as nourishment either to the developed plant or to the embryo. Its chemical composition is C^{12}, H^{10}, O^{10}. Starch may be deposited in seeds, roots, stems, receptacles, &c. Sometimes starch is associated with poisonous or acrid juices. *Inuline* is a substance analogous to starch, and found in Elecampane and other plants; *lichenine*, another variety, is found in Cetraria islandica, or Iceland moss. The action of sulphuric acid, or of malt, on starch, or long boiling in water, results in the production of a soluble substance, called *dextrine*, and is one of the stages through which starch passes to become sugar.

GUM (C^{12}, H^{11}, O^{11}) is another substance found abundantly in the vegetable kingdom, and is one of the forms through which organic matter passes during the growth of plants. There are two forms of gum: one soluble in water (arabine or mucilage), the other only swelling up into a gelatinous mass (bassorine, cerasine, and pectine). *Arabine* is known familiarly as gum arabic; combined with *cerasine* it is found in the gum of the cherry and plum tree. *Mucilage* is present in many plants, as in the mallows and in linseed. *Bassorine* forms the chief part of gum tragacanth. *Pectine* is obtained from pulpy fruits, as the apple and pear. It forms a jelly with water, and when dried resembles isinglass or gelatine.

Sugar occurs in many species of plants, and appears under three principal forms: cane sugar, grape sugar, and mannite. *Cane sugar*, C^{12}, H^9, $O^9 + 2HO$, is obtained from many plants, as sugar cane, beet root, sugar maple, birch, &c. It is soluble in about one third of its weight of water, and insoluble in pure alcohol. *Grape sugar*, or *glucose*, C^{12}, H^{12}, $O^{12} + 2HO$, is found in grape and other juices. It can be prepared from starch or cane sugar by boiling in dilute sulphuric acid. *Mannite*, C^6, H^7, O^6, the chief ingredient of manna, a substance derived from several species of ash, differs from the others in not undergoing the vinous fermentation. It is also found in the juices of celery, mushrooms, &c.

Lignine occurs abundantly in woody fibre, and is distinguished from cellulose in being soluble in strong nitric acid, forming oxalic acid. Its formula is C^{35}, H^{24}, O^{20}. All these substances are readily convertible into each other. Some other ternary compounds of this character are *salicine*, found in the willows, and *phloridzine*, obtained from the bark of the roots of the apple, &c.

There are other vegetable products which differ from these last in the presence of nitrogen. Thus *gluten* is that part of wheat flour which remains after the removal of the starch. *Vegetable fibrine* is obtained by treating the glutinous part of wheat with ether. *Vegetable caseine*, or *legumine*, is found in oily seeds, and in leguminous plants. *Vegetable albumen* occurs as a soluble substance with caseine. It coagulates at a temperature of 140° to 160° F., and is not precipitated by acetic acid. The base of all these substances is proteine (C^{40}, H^{31}, N^5, O^{12}) Fibrine is proteine $+ S + Ph$. Albumen is proteine $+ S^2 + Ph$. Caseine is proteine $+ S$. *Emulsine*, or *synaptase*, is found in almonds; and in bitter almonds is associated with a substance called *amygdaline*. *Diastase* is a modification of gluten, obtained from malt, and developed generally during the germination of plants. It facilitates the conversion of starch into dextrine, and thence into sugar.

Fixed Oils occur in the cells and intercellular spaces of various parts of the plant. They are known by their greasing paper permanently. The principal are linseed oil, olive oil, and certain solid oils, as palm oil, shea butter, and vegetable tallow. These all contain a large amount of stearine.

Vegetable Wax is a peculiar fatty matter found in the stem and fruit of some plants. On the exterior of fruits it constitutes their bloom, as in the grape and plums. Chlorophylle is allied to wax in character, being soluble in ether and alcohol, and insoluble in water.

Volatile, or Essential Oils, are procured from such plants as contain them by distillation in water, and are known as *essences;* they do not grease paper permanently. Usually they are ready formed; sometimes, however, they are produced by a kind of fermentation. Some essential oils consist of carbon and hydrogen, as oil of turpentine, oil of juniper, oil of lemons, &c. A second set contain oxygen in addition, as oil of cinnamon, otto of roses, oils of peppermint, of caraway, and of cloves. Sulphur enters into the composition of a third set, which are distinguished by a peculiar pungent, and sometimes alliaceous smell, as oils of garlic, of onion, of

assafœtida, &c. Camphor is a solid oil, consisting of carbon, oxygen, and hydrogen.

RESINS. These are either liquid or solid. The liquid or balsam of Tolu, of Peru, of copaiva, Canada balsam, &c. The solid are rosin, elemi, sandarac, guiacum, labdanum, dragon's blood, storax, benzoin, copal, lac, &c.

CAOUTCHOUC is found associated with essential oil and resins in the milky juices of plants. It is procured from various species of Ficus, Urceola, Siphonia, &c. GUTTA PERCHA is obtained from a species of Isonandra, found in Singapore and Borneo.

ORGANIC ACIDS occur in great variety in vegetable juices. Thus citric acid is found in the fruit of the orange, the lemon, lime, &c.; tartaric, in the grape; malic, in the apple; tannic, in oak bark and nut-galls; gallic, in the seeds of mango; meconic, in the juice of the poppy; kinic, in Cinchona; hydrocyanic, in the laurel; oxalic, in Oxalis; &c.

ALKALOIDS, or vegetable alkalies, are nitrogenized compounds, found in living plants, and generally containing their active principles. They occur usually in combination with organic acids. Quinine and cinchonine are derived from Cinchona or Peruvian bark; morphine, narcotine, codeine, thebaine, and narceine, from the poppy; solanine, from the potato and other species of Solanum; veratrine, from hellebore; aconitine, from Aconitum; strychnine and brucine, from nux vomica; atropine, from belladonna; piperine, from Piper; emetine, from ipecacuanha; caffeine, from coffee, tea, and Paraguay tea; theobromine, from the cacao; &c.

COLORING MATTERS are obtained from plants, either directly or by means of a species of fermentation. *Yellow* coloring matters are procured from Curcuma longa as turmeric, from the gamboge plant as gamboge, from the stigmata of Crocus sativa as saffron, &c.; also from Reseda luteola (Weld) and from some lichens. The principal *reds* are alkanet from Anchusa; dragon's blood from Dracæna; madder from Rubia tinctorum; logwood from Hæmatoxylon; Brazil wood from Cæsalpinia; carthamine from Carthamus; archil and litmus from Roccella tinctoria, one of the lichens. The principal *blue* is indigo, from various species of Indigofera.

C. THE CIRCULATION AND ELABORATION OF FLUIDS IN PLANTS.

The entrance of liquid matter into the plant is effected mainly through the roots. The extremities of these are covered by a very delicate membrane, which permits the imbibition of liquids with great rapidity. The matter thus absorbed by the roots consists of water holding various matters, chiefly inorganic, in solution; and this is carried up, partly by capillary attraction, partly by endosmosis. This *ascending sap* passes up through the vessels and cells of the stem, and thence into the leaves, where it is elaborated and returned as *descending sap* through the bark, a small portion reaching the roots, there to be excreted, or else stored up for purposes of future nutrition. Gaseous matters are also taken up by the

roots and circulated along with the sap; these consist mainly of air, oxygen, and carbonic acid. In the course of the ascent slight changes take place in the sap, the most important, however, being reserved for the leaves to effect. Here the sap is exposed to the influence of light and air, by means of which carbon and hydrogen are fixed, oxygen and watery vapor given off. The sap thus becomes denser and more fitted to the purposes for which it is destined. After this elaboration it commences its descent, passing through the bark, and transmitted laterally through the cells of the medullary rays. The descending sap, or *latex*, is sometimes clear and transparent, at other times it is milky or otherwise colored. In this are contained the peculiar products of the plant which are deposited in various situations. A mucilaginous deposit between the bark and the wood results in the formation of an external layer to the latter, and an internal to the former. Starch and gum are deposited in the cells of the new layer of alburnum or sap wood, which, in the spring of the year, may be converted into sugar, and by solution in the ascending sap impart to this its sweetness.

ON THE GEOGRAPHY OF PLANTS.

Plants are found distributed all over the surface of the earth, wherever heat, air, and moisture co-exist; and the warmer and moister the country, the more vigorous and varied the vegetation. The same soil, however, is not equally favorable to all plants; this is mainly owing to the fact, that different species require different inorganic ingredients, as well as different amounts of heat, light, and moisture. The mean temperature of a place exerts great influence upon its vegetation, and as this temperature is affected to a certain extent by the latitude and longitude, it becomes possible to establish an intimate relation between geographical localities and particular forms of plants. Besides the *geographical* arrangement of plants, we may also have a *physical* grouping, according to the physical features of the soil in which they are found. Thus plants may grow in water, salt or fresh, they may be found in sandy soils, in meadows, in vegetable mould, under trees, or on other plants, and even on animals. Recent discoveries of the highest interest, by Dr. Leidy of Philadelphia, have shown that the occurrence of entophyta in animals is perfectly normal. The following arrangement by Balfour, exhibits the general features of a division of plants, according to their station.

A. Plants Growing in Water, whether Salt or Fresh.

1. *Marine Plants*, such as sea-weeds, Lavers, &c., which are either buried in the ocean or float on its surface; also, such plants as *Ruppia* and *Zostera*. In the Sargasso Sea there are floating meadows of *Sargassum bacciferum*—gulf-weed. This sea extends from 22° to 36° north latitude, and from 25°

to 45° west longitude from Greenwich, and extends over 40,000 square miles.

2. *Maritime, or Saline Plants.* These are plants which grow on the border of the sea, or of salt lakes, and require salt for nourishment, as *Salicornia*, glasswort, *Salsola*, saltwort, *Anabasis.* Such plants are often called Halophytes. Under this head may be included littoral and shore plants, such as *Armeria*, sea-pink, *Glaux*, and *Samolus.*

3. *Aquatic Plants*, growing in fresh water, either stagnant or running, as *Sagittaria*, arrowhead, *Nymphæa*, water-lily, *Potamogeton*, pond-weed, *Subularia*, awlwort, *Utricularia*, bladderwort, *Stratiotes*, water-soldier, *Lemna*, duck-weed, *Pistia*, *Confervæ*, *Oscillatoriæ*, and *Ranunculus fluviatilis.* Some of these root in the soil, and appear above the surface of the water; others root in the soil, and remain submerged; while a few swim freely on the surface without rooting below.

3. *Amphibious Plants*, living in ground which is generally submerged, but occasionally dry, as *Ranunculus aquatilis* and *sceleratus*, *Polygonum amphibum*, *Nasturtium amphibium.* The form of the plants varies according to the degree of moisture. Some of these, as *Limosella aquatica*, grow in places which are inundated at certain periods of the year; others, such as *Rhizophoras*, mangroves, and *Avicennias*, form forests at the mouths of muddy rivers in tropical countries.

B. Land Plants which Root in the Earth and Grow in the Atmosphere.

Sand Plants; as *Carex arenaria*, *Ammophila arenaria*, *Elymus arenarius*, and *Calamagrostis arenaria*, which tend to fix the lose sand. *Plantago arenaria*, *Herniaria glabra*, *Sedum acre.*

6. *Chalk Plants;* plants growing in calcareous soils, as some species of *Ophrys*, *Orchis*, and *Cypripedium.*

7. *Meadow and Pasture Plants;* as some species of *Lotus*, bird's foot trefoil, a great number of grasses and trefoils, the daisy, dandelion, and buttercups.

8. *Plants Found in Cultivated Ground.* In this division are included many plants which have been introduced by man along with grain, as *Centaurea cyanus*, corn blue-bottle. *Sinapis arvensis*, common wild mustard, *Agrostemma*, corncockle, several species of *Veronica* and *Euphorbia*, *Lolium temulentum*, *Convolvulus arvensis*, *Cichorium intybus;* also plants growing in fallow ground, as *Rumex acetosella*, *Carduus nutans*, *Echium vulgare*, *Artemisia campestris*, and *Androsace septentrionalis.* In this division garden weeds are included; such as Groundsel, Chickweed, *Lamium amplexicaule*, *Chenopodium vulgare* and *viride.*

9. *Rock or Wall Plants;* Saxifrages, Wall-flower, *Linaria cymbalaria*, *Draba muralis*, species of *Sisymbrium* and *Sedum*, *Asplenium*, *Ruta muraria*, and some lichens and mosses.

10. *Plants Found on Rubbish Heaps*, especially connected with old

buildings. Some of these seem to select the habitations of man and animals, on account of certain nitrogenous and inorganic matters which enter into their composition. Among them may be noticed Nettles, Pellitory, Docks, Borage, Henbane, *Xanthium*. Here also have been placed some plants immediately connected with the habitation of man, such as *Racodium cellare*, a fungus found on wine casks; *Conferva fenestralis*, an alga produced on window-panes; and *Conferva dendrita*, one developed on paper. Some plants, as *Sempervium tectorum*, select the roofs of houses.

11. *Plants growing in Vegetable Mould*, such as bog plants, or those growing on wet soil, so soft that it yields to the foot, but rises again; and marsh plants, growing in wet soil, which sinks under the foot and does not rise. To the former class belong such plants as *Pinguicula alpina* and *Primula farinosa;* to the latter, such as *Menyanthes*, *Comarum*, *Bidens cernua*.

12. *Forest Plants*, including trees which live in society, as the Oak, the Beech, Firs, &c., and the plants which grow under their shelter, as the greater part of the European Orchises, some species of *Carex* and *Orobanche*. Some plants especially grow in pine and fir-woods, as *Linnæa borealis* and some Pyrolas.

13. *Plants of Sterile Places*, found in barren rocks, by road-sides. This is a heterogeneous class, and contains many plants of uncertain character. Under it are included the plants of uncultivated grounds, as those found on moors, where *Calluna vulgaris*, common heath, and various Heaths, Juniper, *Andromeda*, and some species of *Polytrichum* occur.

14. Plants of the thickets or hedges, comprehending the small shrubs which constitute the hedge or thicket, as the Hawthorn and Sweet-brier; and the herbaceous plants which grow at the foot of these shrubs, as *Adoxa*, Wood Sorrel, Violets; and those which climb among their numerous branches, as Bryony, Black Bryony, Honeysuckle, Traveller's Joy, and some species of *Lathyrus*.

15. *Plants of the Mountains*, which De Candolle proposes to divide into two sections: 1. Those which grow on Alpine mountains, the summits of which are covered with perpetual snow, and where, during the heat of summer, there is a continual and abundant flow of moisture, as numerous Saxifrages, Gentians, Primroses, and Rhododendrons. 2. Those inhabiting mountains on which the snow disappears during summer, as several species of Snap-dragon, among others the Alpine Snap-dragon. Umbelliferous plants, chiefly belonging to the genus *Sesseli*, meadow Saxifrage, Labiate plants, &c.

C. Plants Growing in Special Localities.

16. *Parasitic Plants*, which derive their nourishment from other vegetables, and which, consequently, may be found in all the preceding situations; as the Mistletoe, species of *Orobanche*, *Cuscuta* (Dodder), *Loranthus*, *Rafflesia*, and numerous Fungi.

17. *Pseudo-parasitic Plants*, or Epiphytes, which live upon dead

vegetables, as Lichens, Mosses, &c., or upon the bark of living vegetables, but do not derive much nourishment from them, as *Epidendrum*, *Aerides*, and other orchids, as well as *Tillandsia*, *Bromelia*, *Pothos*, and other air plants.

18. *Subterranean Plants*, or those which live under the ground, or in mines and caves almost entirely excluded from the light, as *Byssus*, Truffles, and some other cryptogamic plants.

19. *Plants which Vegetate in Hot Springs*, the temperature of which ranges from 80° to 150° Fahrenheit's thermometer, as *Vitex Agnus-castus*, and several cryptogamous plants, as *Ulva thermalis*, the hot-spring Laver.

20. *Plants which are Developed in Artificial Infusions or Liquors*, as various kinds of *Mucor*, causing mouldiness.

21. *Plants Growing on Living Animals*, as species of *Sphæria* and *Sarcinula*, and various other Fungi and Algæ.

22. Plants growing on certain kinds of decaying animal matter, such as species of *Onygena*, found on the hoofs of horses, feathers of birds, &c., some species of Fungi, which grow only on the dung of animals, and certain species of *Splachnum*.

There are certain forms of plants which, while occurring within definite limits, impart a peculiar character. Meyen, in his *Grundriss der Pflanzengeographie*, establishes twenty groups as especially characteristic of the regions in which they occur. They are as follows:

1. *Gramineous, or Grassy Form.* This is illustrated in northern countries by meadows and pastures. The cereal grains also have a great influence on the aspect of countries. Under this form are included Cyperaceæ, Restiaceæ, and Juncaceæ. In the torrid zone some arborescent forms occur, as Bamboo; and along with these are associated Sugar-cane and Rice. Barley is an extra tropical form, while Carex extends to cold regions.

2. *Scitamineous Form.* This includes the Ginger, Arrowroot, and Plantain family, some of which attain a large size. They contribute to give a character to the torrid zone.

3. *Pandanus, or Screw-pine Form.* A tropical form illustrated by Screw-pines and Dracænas.

4. *Pine-Apple Form.* Illustrated by the Bromeliaceæ of warm climates.

5. *The Agave, or American Aloe Form.* Chiefly tropical and subtropical.

6. *The Palm Form.* Under this are included also the Cycadaceous family. They give a character to the hotter regions of the globe. Some of the palms are social, as the Date and Cocoa-nut. *Chamærops humilis* represents this form in Europe.

7. *Filical, or Fern Form.* True Ferns, in an especial manner, affect the landscape in tropical and warm regions.

8. *Mimosa Form.* This includes Leguminous plants in general. The finely cut foliage of some has a resemblance to Ferns. Modifications of this form occur both in warm and cold regions. Acacias, in New Holland, give a peculiar feature to the landscape.

9. *Coniferous Form.* The Abietinæ are characteristic of northern regions, and Cupressineæ of southern.

10. *The Protea, Epacris, and Erica Forms.* These forms supply the place of Coniferæ in the southern hemisphere; the Protea and Epacris forms occurring in Australasia, and the Erica form at the cape of Good Hope.

11. *Myrtle Form.* Some of these, such as Melaleuca and Eucalyptus, characterize New Holland Scenery; others, as Guavas, are tropical.

12. *Forms of Dicotyledonous Trees.* Some, with broad and tender leaves, as Birch, Alder, Poplar, Oak, Lime, Elm, Beech, and Horse-chestnut, giving a character to the physiognomy of the colder half of temperate climates; while others, with thick, leathery, and showy leaves, as Olives and Laurels, are characteristic of warmer climates; and a third division, with large, beautiful leaves, Cecropia, Artocarpus, and Astrapæa, abound in the hottest climates.

13. *Cactus Form.* This form is developed chiefly in America, especially in Brazil.

14. *Form of Succulent Plants.* Seen in the Mesembryaceæ of South Africa.

15. *Lily Form.* This includes Liliaceæ, Amaryllidaceæ, and Iridaceæ. Modifications of this form occur in warm and temperate climates.

16. *Forms of Lianas, or Climbing-Plants.* These forms are chiefly tropical, and are illustrated by Passion-flowers, Paullinias, Aristolochias, and Bauhinias.

17. *Pothos Form.* This is a tropical form, and is illustrated by various species of Araceæ.

18. *Orchideous Form.* This is seen in the splendid Epiphytes of warm climates. Terrestrial species chiefly occur in cold zones.

19. *The Moss Form.*

20. *The Lichen Form.* Both these forms characterize cold regious chiefly.

In treating of the geographical arrangement of plants, we may consider them under two points of view; *first*, as respects the horizontal or latitude arrangement; and *second*, in respect to the vertical range. The mean temperature of the earth diminishes as we travel from the equator towards either pole, as also in ascending to the top of a high mountain from its base; so that there is a certain parallelism between the horizontal range of mean temperature and the vertical. The same is the case in plants, as we shall find that the same mean temperature, whether we attain this by a horizontal or by a vertical progression, is characterized by the same vegetable features.

Considering, in the first place, the horizontal range of vegetation, we find the following to be the divisions of Meyen, the latest authority on the subject:—

A. Torrid Zone.

1. Equatorial Zone. 0°—15°. Mean annual temperature 78½°—82½° F., characterized by the greatest size and variety of forms, with the most brilliant colors and exquisite odors, primitive forests with gigantic trees, and climbing plants. The characteristic forms are Palms, Bananas, Arborescent Grasses, Pandanus, Scitamineæ, Orchids, Lianas, and Epiphytes; also, plants belonging to Cedrelaceæ, Sapindaceæ, Cæsalpineæ, Malvaceæ, Anonaceæ, Anacardiæ, Artocarpeæ, Lecythidaceæ, Malpighiaceæ, &c.

2. The Tropical Zone. 15°—23°. Mean temperature 73½°—78¾° F. Summer temperature 80½°—86°; winter temperature in the eastern coast countries 59°. Palms, Musaceæ, Scytamineæ, Meliaceæ, Arborescent Ferns, Orchidaceæ, Araceæ, and Lianas. Plains with Melastomaceæ and gentians in the New World. Forests of mangrove and figs in the Old World.

B. Temperate Zone.

3. Subtropical Zone. 23°—34°. Mean temperature 62½°—71½°; mean summer temperature 73½°—82½°: winters mild and vegetation green throughout the year.

Northern hemisphere. Old World: Pancratia, Dracaenæ, Bananas, Palms (*Crucifera thebaica*, *Phœnix dactylifera*, *Chamærops humilis*), *Ficus sycamorus*, Cordia, Cissus, Capparis, Melia, Camellia, Euphorbiaceæ, Pistacia, Bauhinia. New World: Arborescent grasses, Tillandsia on Pinus, Taxodium, Quercus, Populus, *Laurus sassafras*, Myrica, Diosphyros, Magnolia, Liriodendron, Calycanthus, and climbing Bignonias.

Southern hemisphere. New Holland: *Anthistiria australis* and *Polygonum junceum.* Forests of Eucalyptus, Cycadeæ, Xanthorrhea, Callitris, Casuarina, Proteaceæ, Dilleniaceæ, Papilionaceæ and Mimosas, Terrestrial Orchideæ, Stylidia and Goodenia. South Africa: Cycadeæ, Restiaceæ, Juncaceæ, Irideæ, Compositæ, Erica, *Podocarpus elongatus*, with Asclepiadeæ and Bryonia, Mesembryanthemum and Epiphytes. La Plata: shrubs with leathery leaves; woody Compositæ, Cestrum, Colletia, Fuchsia, Myrtles, and Papilionaceæ embraced by Mutisia, Bignoniaceæ, Cuscuta, and Loasaceæ. Abundant in Loranthaceæ, Cactaceæ, Liliaceæ, and arborescent grasses.

4. Warmer Temperate Zone. 34°—45°. Mean temperature 53½°—62½°. Summer temperature in North America 77°; in Europe 75¼°—68°; in eastern Asia, 82¼°. Winter temperature in America 44½°—32½°; in Europe 50°—34¾°; in eastern Asia 26½°.

Northern hemisphere. Evergreen trees with vines, Bignonias, and spinous roses, Quercus, Fagus, Castanea, Platanus, Laurus, Fraxinus, Acer, Juglans, Myrtus, Gleditschia, Vaccinium, *Viburnum tinus*, Arbutus uredo and andrachne, Smilaceæ, Aster, Solidago, Labiatæ, Cistineæ, Caryophylleæ. Meadows are of rarer occurrence.

Southern hemisphere. New Zealand: *Cordyline australis*, *Phormium*

tenax, *Areca sapida*, &c. Van Diemen's Land and New Holland: Proteaceæ, Epacrideæ, Leptospermeæ. Chili and Buenos Ayres: Fagus, Laurelia, Persea, Weinmannia, Coriaria, Myrtus, &c.

5. Colder Temperate Zone. 45°—58° of latitude. Mean temperature 43°—53½° F.; minimum summer temperature on the west coast 56¼°; in the interior of the continent 68°; minimum winter temperature in the interior of Europe 14°.

Northern hemisphere; Europe: Corylus, Viburnum, extended green meadows; great heaths covered with Calluna vulgaris. Turf with Juniperus, *Andromeda polifolia* and *Ledum palustre;* rich in Umbelliferæ and Cruciferæ. Asia: Anabasis, Salsola, Chenopodium, Atriplex, Statice, Artemisia, Gentiana, *Cucubalus tatarica*, Glycyrrhiza. America: Abietineæ, Sisyrinchium, Dodecatheon, *Panax horridum*, *Rubus odoratus*, and *spectabilis*, Sorbus and Cratægus.

Southern hemisphere. Evergreen forests of *Fagus antarctica* and betuloides, with *Wintera aromatica*, Podocarpus. Here and there, no trees (Falkland Islands and east side of the Straits of Magellan), but instead, shrubby growths of considerable extent of Andromeda, Arbutus, Empetrum, and Rubus, 4–5 feet high. Extensive meadows of *Agrostis magellanica* and *cæspitosa*, *Aira flexuosa*, *Avena redolens* and *phleoides*, *Festuca magellanica* and *erecta*, Carex and Juncus. Moors of *Sphagnum acutifolium*, with *Marchantia polymorpha*, *Azolla magellanica*, Lomaria, *Callitriche verna*, Gunnera, *Statica armeria*, *Galium aparine*, *Pinguicula alpina*, *Lysimachia repens*, *Ranunculus lapponicus*, *Caltha appendiculata* and *sagittata*, with Fuchsia and Sanguisorba.

6. The Subarctic Zone. 58°—66° of latitude. Mean temperature 39¼°—43° F.; summer temperature in the New World 66¼°; in the Old, 60¾°—68°. Winter temperature of western Europe 14°; of the interior of Russia 14°—10½°. Vegetation very similar through Scandinavia, Siberia, Kamtschatka, Northern America, Iceland, and the Faroe Islands. Pines, Firs, Larches, Birches, and Willows predominate; characteristic growths are *Cetraria islandica*, *Trichostomum lanuginosum* and *canescens*. Meadows of Agrostis, Poa and Aira, Valeriana, *Hieracium aurantiacum*, *Digitalis purpurea*, Stachys, Swertia, Lysimachia, Trientalis, *Calluna vulgaris*, *Erica cinerea*, Bunium, Ribes, Chrysoplenium, Berberis, Hypericum, *Prunus padua*, Rosa, Trifolium.

The South Subantarctic Zone (New Shetland) has the polar character.

C. Frigid Zone.

7. The Arctic Zone. This extends from the Arctic circle 66° to 72°. Mean temperature 28½°—32°, and towards the eastern and continental portions far below this. This constitutes the limit of arboreal vegetation and of cultivated plants. Characteristic growths common to both continents are Gyrophora, *Cenomyce rangiferina*, Polytrichum, *Aira cæspitosa* and *flexuosa*, *Pinus sylvestris* and *abies*, *Betula nana* and *glandulosa*, *Alnus glutinosa*, *Populus tremula*, Salix, Diapensia, *Cornus suecica*, Azalea, Andromeda, Vaccinum, *Rubus chamæmorus* and *Sorbus aucuparia*.

8. The Polar Zone. This includes all lands from 72° to the pole. The mean temperature of one point in this zone, Melville Island, is 1½°. In the Old World the mean temperature is 16½°. Summer temperature of the New World 37½°, of the Old 38¼°. Winter temperature 28° in the New and 2¼° in the Old. Spitzbergen, Greenland, the coast of Baffin's Bay, Melville Island, Northern Siberia, and Nova Zembla, exhibit the same species, with few exceptions. Trees and shrubs wanting. Small turfy plants with creeping roots. Poor in genera, species, and individuals. Characteristic genera are Phippsia, Colpodium, Dupontia, Pleuropogon, Eriophorum, Juncus, Salix, Pedicularis, Andromeda, Pyrola, Saxifraga, Cochlearia, Cardamine, Parrya, Platypetalum, Eutrema, Papaver, Ranunculus, Silene, Potentilla, and Dryas. Few Monocotyledons, and these not above the grass type. Almost total destitution of Apetala and Monopetala.

Vertical Range of Plants.

The relation between altitude and vegetation is best seen in ascending high mountains in tropical regions, where all gradations, from the heat of the Torrid Zone to the cold of the Arctic regions, may be passed through in regular succession. We quote a striking illustration of this circumstance from Humboldt:—

"In the burning plains, scarce raised above the level of the southern ocean, we find Bananas, Cycadaceæ, and Palms, in the greatest luxuriance; after them, shaded by the lofty sides of the valleys in the Andes, Tree Ferns; next in succession, bedewed by cool misty clouds, Cinchonas appear. When lofty trees cease, we come to Aralias, Thibaudias, and myrtle-leaved Andromedas; these are succeeded by Bejarias abounding in resin, and forming a purple belt around the mountains. In the stormy regions of the Paramos, the more lofty plants and showy flowering herbs disappear, and are succeeded by large meadows covered with grasses, on which the Llama feeds. We now reach the bare trachyte rocks, on which the lowest tribes of plants flourish. Parmelias, Lecidias, and Leprarias, with their many-colored sporules, form the flora of this inhospitable zone. Patches of recently fallen snow now begin to cover the last efforts of vegetable life, and then the line of eternal snow begins.

"On the mountains of temperate regions the variety is rather less, but the change is not less striking. We begin to ascend the Alps, for instance, in the midst of warm vineyards, and pass through a succession of oaks, sweet chestnuts, and beeches, till we gain the elevation of the more hardy pines and stunted birches, and tread on pastures fringed by borders of perpetual snow. At the elevation of 1950 feet, the vine disappears; and 1000 feet higher, the sweet chestnuts cease to grow; 1000 feet further, and the oak is unable to maintain itself; the birch ceases to grow at an elevation of 4680, and the spruce fir at the height of 5900 feet, beyond which no tree appears. The *Rhododendron ferrugineum* (the Rose of the Alps) then covers immense tracts to the height of 7480 feet, and *Salix herbacea* creeps 200 or 300 feet

higher, accompanied by a few Saxifrages, Gentians, and Grasses, while Lichens and Mosses struggle up to the imperishable barrier of perpetual snow."

Some authors establish five regions of mountain vegetation, including 1. the region of Lowland cultivation; 2, Region of woods; 3, Region of shrubs; 4, Region of grasses; and 5, Region of Cryptogamous plants. A more elaborate classification by Meyen is as follows:

1. *Region of Palms and Bananas.*

0 to 1900 feet high. Temperature 80¾° to 86° F. Corresponds to the equatorial zone.

Forests of Mangrove at the sea coasts, and at the mouths of rivers. Arborescent grasses covering extensive tracts, dense forests of fig trees, Tournefortia, Dodonea, Barringtonia, Mimosa, &c., overtopped by palms, Musaceæ, and Scitamineæ.

2. *Region of Tree Ferns and Ficus.*

1900 to 3800 feet high. Temperature 74° F. Corresponds to the tropic zone.

Arborescent ferns from 20 to 30 feet high, Cinchonaceæ, Artocarpus, and Ficus, with Reed Palms, and Passifloræ. The undergrowth of Acanthaceæ Tiliaceæ, Euphorbiaceæ, mixed with Aroideæ and Piperaceæ.

3. *Region of the Myrtles and Laurels.*

3800 to 5700 feet high. 68° to 69.8° F. Corresponds to the subtropical zone.

Dicotyledonous trees, with glossy leaves, shrubby ferns, Quercus, Liquidambar, Laurineæ, Proteaceæ, Rubiaceæ, Erica, Styrax, Sapindaceæ, Malpighiaceæ, Melastoma, Myrtus, Eugenia, Eucalyptus, Acacia.

4. *Region of Evergreen Dicotyledonous Trees.*

5700 to 7600 feet high. Temperature, 62.6° F. Corresponding to the warmer temperate zone.

Quercus, Laurineæ, Melastomaceæ, Myrtaceæ, Colletia, Cactaceæ.

5. *Region of Deciduous Dicotyledonous Trees.*

7600 to 9500 feet high. Temperature, 57.2° F. Corresponding to the colder temperate zone.

Forests of Oak, Beech, and Maple, with Ternstroemia, Euphorbiaceæ, and Melastomaceæ, many Coniferæ.

6. *Region of Abietineæ.*

9500 to 11,400 feet high. Temperature, 51.8° F. Corresponds to the subarctic zone.

In the Peruvian Andes, instead of Coniferæ there occur Escalloniæ, Wintera granatensis, and Andromedæ, with Swertia. In the Mexican plateaus, in addition to the Abietineæ, there are forests of Oak and Yucca, Tillandsia and Cactaceæ, with Stevia arenaria, Ranunculus, and Astragalus.

7. *Region of Alpine Shrubs, or of Rhododendronna.*

11,400 to 13,300 feet high. Temperature 44.6° F. Corresponds to the arctic zone.

No trees, only shrubs ; Rhododendrons, Astragalus, Befaria, Cactus, Calceolaria.

8. *Region of Alpine Plants.*

13,300 to 15,200 feet high. Temperature, 37½° to 39½° F. Corresponds to the polar zone.

In the northern Cordilleras, Compositæ, Mimulus, Calceolaria, Sida, Lupinus ; in the southern, Lecidea geographica, grasses, Plantago, Gentiana, Befaria, Mullinsia, Epilobium. In the mountains of Java, Valeriana, Gentiana, Viola, Ranunculus, Potentilla, Draba, Primula, Salix, Astragalus, Phyteuma, &c.

Pl. 73, *fig.* 1, presents a general view of those cultivated plants, which furnish the principal articles of food and medicine: the various Cerealia, Cacao, Sugar, Coffee, Tea, Cinnamon, Pepper, Nutmeg, Vanilla, Clove, Cotton, and Peruvian Bark. *Fig.* 2 is a more detailed exhibition of the Chinese and East Indian region of cotton, tea-plant, cinnamon tree, pepper, &c. *Fig.* 3 is a special chart of the region of the sugar-cane, coffee, and cacao tree, of tea, vanilla, &c., in the West Indies and South America. The remaining four figures present to us the vertical distribution of plants. *Fig.* 4 represents this distribution in the temperate zone of Asia. From the foot of the Himalayas to the middle of the region, between 3 and 4, no snow occurs ; and up to a point half-way between 4 and 5, the snow vanishes before the rainy season, and the tropical herbaceous plants cease to exist. Oaks are found at 4. Rhododendrons at 6, &c. At a height from 1 to a region between B and 4, we find first the dwarf palm, higher up the long-leaved fig, Shorea robusta, and finally oaks. Between C and D is the region of sugar plantations ; between D and E, that of the Deodora Cedar ; between E and F are found wheat, walnut, and almond trees, &c. ; between F and

G, the white Birch, Juniper, &c.; and above all, at G, there occurs Genista versicolor. *Fig.* 5 represents the distribution of American plants. Thus the palm is found up to A; arborescent ferns to B; the grape to C; cinnamon to D; oaks and the Mexican alder to E; Pinus occidentalis to F; maize to G (probable snow line of Aconcagua); barley to H. On the eastern side, Pinus occidentalis at F, and the Mexican alder and oaks at G. *Fig.* 6 illustrates the temperate zone of Europe; the grape, chestnut and walnut, up to A; to B, oaks, white birch, red birch; to C, Pinus picea and abies; to D, Alnus viridis and Rhododendron; to E, Salix herbacea; F to G, Pinus rubra; to H, oaks; and the chestnut, the grape, &c., down to the foot again. *Fig.* 7 refers to the Canary Islands: to A, Palms; to B, Cerealia and the grape; to C, Laurel trees; to D, Pinus canariensis; to E, Spartium rubiginosum; and to F, a species of Viola. *Fig.* 8 shows the distribution of plants in the frigid zone of Europe; Pinus sylvestris to A; the white birch to B; and to C, salix herbacea and lanata.

SYSTEMATIC BOTANY, OR THE CLASSIFICATION OF PLANTS.

It does not come within the scope of the present work to give a history of the rise and progress of the science of Botany, nor to enumerate the various systems of classification which have been propounded. We will merely state that such systems are either artificial or natural. The most important artificial system is that of Linnæus, which, better perhaps than any other system affords an index to the genera. The objection to this and to other artificial systems is, that genera and species of very different character are necessarily brought together, while their affinities and truly essential characters may be wholly opposite. Up to a comparatively recent period the system of Linnæus almost exclusively prevailed; few botanists of the present day, however, make any other use of it than that of a key or index. In this system twenty-three classes are founded on the number, relative lengths, position, and connexion of the stamens; the orders in these classes depending on the number of styles, the nature of the fruit, occasionally the number of stamens, and the perfection of the flowers. The twenty-fourth class includes plants with inconspicuous flowers. The following is a tabular view of the system as analysed by Balfour.

Tabular View of the Classes *of the Linnæan System.*

A. Phanerogamia (Flowers present):
I. Stamens and Pistil in every flower.
1. Stamens free.
a. Stamens of equal length, or not differing in certain proportions:

Class	I. Monandria	with one	stamen.
"	II. Diandria	"	two	stamens.
"	III. Triandria	"	three	"
"	IV. Tetrandria	"	four	"

Class	V.	Pentandria	with five	stamens.	
"	VI.	Hexandria	" six	"	
"	VII.	Heptandria	" seven	"	
"	VIII.	Octandria	" eight	"	
"	IX.	Enneandria	" nine	"	
"	X.	Decandria	" ten	"	
"	XI.	Dodecandria	" 12 to 19	"	
"	XII.	Icosandria	" 20 or more	"	inserted on calyx.
"	XIII.	Polyandria	" 20 or more	"	" " receptacle.

b. Stamens of different lengths:

Class	XIV.	Didynamia	" two short and two long stamens.
"	XV.	Tetradynamia	" two short and four long.

2. Stamens united.

a. By filaments:

Class	XVI.	Monadelphia	"	stamens in one bundle.
"	XVII.	Diadelphia	"	" in two bundles.
"	XVIII.	Polyadelphia	"	" in more than two bundles.

b. By anthers (compound flowers):

Class	XIX.	Syngenesia	"	" united by anthers.
"	XX.	Gynandria	"	" and pistil on a column.

II. Stamens and pistil in different flowers.

1. On the same plant:

Class XXI. Monœcia.

2. On different plants:

Class XXII. Diœcia.

III. Stamens and pistils in the same or in different flowers, on the same or on different plants:

Class XXIII. Polygamia.

B. Cryptogamia (flowers absent):

Class XXIV. Cryptogamia.

Tabular View of the Orders *of the Linnæan System.*

A. Classes I to XIII. subdivide into:

Order	1.	Monogynia	with one		free style.
"	2.	Digynia	" two	"	styles.
"	3.	Trigynia	" three	"	"
"	4.	Tetragynia	" four	"	"
"	5.	Pentagynia	" five	"	"
"	6.	Hexagynia	" six	"	"
"	7.	Heptagynia	" seven	"	"
"	8.	Octogynia	" eight	"	"
"	9.	Enneagynia	" nine	"	"
"	10.	Decagynia	" ten	"	"
"	11.	Dodecagynia	" 12 to 19	"	"
"	12.	Polygynia	" 20 or more	"	"

B. Class XIV. subdivides into:

Order 1. Gymnospermia with the fruit formed by four Achænia.

" 2. Angiospermia " " " a two-celled capsule with many seeds.

C. Class XV. subdivides into:

Order 1. Siliculosa: fruit, a Silicula.

" 2. Siliquosa: fruit, a Siliqua.

D. Classes XVI. to XVIII. subdivide into:

Orders: Triandria, Tetrandria, Decandria, &c., according to the number of stamens.

E. Class XIX. subdivides into:

Order 1. Polygamia æqualis: florets all hermaphrodite.
" 2. " superflua: florets of the disk hermaphrodite, those of the ray pistilliferous and fertile.
" 3. " frustranea: florets of the disk hermaphrodite, those of the ray neuter.
" 4. " necessaria: florets of the disk staminiferous, those of the ray pistilliferous.
" 5. " segregata: each floret having a separate involucre.
" 6. Monogamia. Anthers united, flowers not compound.

F. Classes XX. to XXII. subdivide into:

Orders: Monandria, Diandria, &c., according to the number of stamens.

G. Class XXIII. subdivides into:

Order 1. Monœcia: Hermaphrodite, staminiferous, and pistilliferous flowers on the same plant.
" 2. Diœcia: the same on two plants.
" 3. Triœcia: the same on three plants.

H. Class XXIV. subdivides into:

Order 1. Filices: Ferns.
" 2. Musci: Mosses.
" 3. Hepaticæ: Liverworts.
" 4. Lichenes: Lichens.
" 5. Algæ: Seaweeds.
" 6. Fungi: Mushrooms.

The object in the natural system is to combine those plants which are allied in essential points of structure. Every natural method is, however, to a certain extent artificial, and it will be impossible to construct a perfect natural system until all the plants of the globe are known. The first natural system of much special value was that of Jussieu, published in 1789. This includes one hundred natural orders or groups of genera, the whole arranged under fifteen classes, as follows:

Natural System according to Jussieu.

					Class
Acotyledones,					I.
Monocotyledones,	*Mono-hypogynæ* (Stamens hypogynous),				II.
	Mono-perigynæ (" perigynous),				III.
	Mono-epigynæ (" epigynous),				IV.
Dicotyledones,	*Monoclines* (flowers united)	Apetalæ (No petals)	Epistamineæ (Stamens epigynous)		V.
			Peristamineæ (" perigynous)		VI.
			Hypostamineæ (" hypogynous)		VII.
		Monopetalæ (Petals united)	Hypocorollæ (Corolla hypogynous)		VIII.
			Pericorollæ (" perigynous)		IX.
			Epicorollæ (Corolla epigynous)	Synantheræ (anthers united)	X.
				Corisantheræ (anthers free)	XI.
		Polypetalæ (Petals distinct)	Epipetalæ (petals epigynous).		XII.
			Peripetalæ (" perigynous).		XIII.
			Hypopetalæ (" hypogynous).		XIV.
	Diclines (flowers unisexual or without a perianth).				XV.

The philosophical system of Endlicher divides plants into two regions and five sections, as follows:

Natural System according to Endlicher.

Region I. Thallophyta (frond plant). No opposition of stem and root. No spiral vessels, and no sexual organs. Propagated by spores.

Section 1. *Protophyta.* Developed without soil; deriving nourishment all around; fructification indefinite.

Section 2. *Hysterophyta.* Developed on decaying organisms; nourished internally from a matrix; all the organs appearing at once, and perishing in a definite manner.

Region II. Cormophyta. Opposition of stem and root. Spiral vessels and sexual organs distinct in the more perfect.

Section 3. *Acrobrya.* Stem increasing by the apex, the lower part being unchanged, and only conveying fluids.

Cohort 1. Anophyta. No spiral vessels. Both sexes present. Spores free within spore-cases.

Cohort 2. Protophyta. Bundles of vessels more or less perfect. No male organs. Spores free within one or many-celled spore-cases.

Cohort 3. Hysterophyta. Both sexes perfect. Seeds without an embryo, consisting of many spores. Parasitic.

Section 4. *Amphibrya.* Stem increasing at the circumference. Vegetation peripherical.

Section 5. *Acramphibrya.* Stem increasing both by apex and circumference. Vegetation peripherico-terminal.

Cohort 1. Gymnospermæ. Ovules naked, receiving the fecundating matter directly at the micropyle.

Cohort 2. Apetalæ. Perigone either wanting or rudimentary or simple, calycine or colored, free or adherent to the ovary.

Cohort 3. Gamopetalæ. Perigone double; outer calycine, inner coralline; gamopetalous, rarely wanting by abortion.

Cohort 4. Dialypetalæ. Perigone double; outer calycine, parts distinct or united, free or attached to the ovary; inner coralline. parts distinct or very rarely cohering by means of the base of the stamens; insertion hypogynous, perigynous, or epigynous; sometimes abortive.

Under these sections are enumerated 279 natural orders, grouped under sixty-one classes.

The arrangement which we have selected to be the basis of our classification is that of De Candolle, as modified by certain more recent authors.

Natural System according to De Candole.

A. Cryptogamus or Cellular Flowerless Plants.

Class 1. *Acotyledons or Acrogenæ.*

Sub-Class 1. Amphigamæ, Thallogenæ, or Cellulares: entirely cellular.
" 2. Ætheogamæ, or Cormogenæ: having vascular tissue.

B. Phanerogamous or Vascular Flowering Plants.

Class 2. *Monocotyledons, or Endogenæ.*

Sub-Class 1. Glumaceæ. Floral envelopes imbricated, leaves parallel-veined.
2. Petaloideæ or Florideæ. Floral envelopes, verticillate leaves, parallel veined.
a. Unisexual, often achlamydeous.
b. Hermaphrodite, ovary free.
c. Hermaphrodite, ovary adherent.
3. Dictyogenæ. Floral envelopes verticillate, leaves reticulated.

Class 3. *Dicotyledones or Exogenæ.*

Having a single perianth,	Sub-Class 1. Monochlamydeæ. A calyx only, or none. *a.* Gymnospermæ. Seeds naked, *b.* Angiospermæ. Seeds in an ovary,	Apetalæ and partly Diclines of Jussieu.
Having Calyx and Corolla Dichlamydeæ.	" 2. Corollifloræ. Petals united, bearing the stamens,	Monopetalæ of Jussieu.
	" 3. Calycifloræ. Petals distinct, stamens perigynous " 4. Thalamifloræ. " " " hypogynous	Polypetalæ of Jussieu.

Before proceeding to the more particular consideration of the orders of the system, we shall make a brief reference to the more usual symbols and abbreviations as used in botanical descriptions.

The authorities for genera and species are given by adding the abbreviated name of the botanist who described them. Thus, *Veronica L.* is the genus Veronica as defined by Linnæus; *Veronica arvensis L.* is a certain species of Veronica, defined by the same author; *Oxytropis DC.* is the genus as defined by De Candolle. It is usual in descriptive works to give a list of the authors, and the symbols for their names. The abbreviation *v. s. sp.*, means *vidi siccam spontaneam*, or that the author has seen a dried wild specimen of the plant; *v. s. c.* means *vidi siccam cultam*, or that he has seen a dried cultivated specimen; *v. v. s.* means *vidi vivam*

spontaneam, or that he has seen a living wild specimen; while *v. v. c.* means *vidi vivam cultam*, or that the author has seen a living cultivated specimen. The asterisk prefixed to a name (*L), indicates that there is a good description at the reference given to the work; while the dagger (†L), implies some doubt or uncertainty. The point of admiration (! DC), marks that an authentic specimen has been seen, from the author named; and the point of interrogation (?) indicates doubts as to the correctness of genus, species, &c., according as it is placed after the name of the one or other. ☉, ○, ①. or A, annual; ♂, ☉☉, ②, or B, biennial; ♃, △, or P, perennial; ♄, or Sh., shrub;), twining to the left; (, twining to the right; ☿, hermaphrodite; ♂, male; ♀, female: ♂ — ♀, monœcious, or the male and female on one plant; ♂ : ♀, diœcious, or the male and female on different plants; ∞ or 8, means indefinite in number.

Section A. Cryptogamous Plants.

Class 1. *Acotyledones*, Juss. *Acrogens and Thallogens*, Lindl.

The plants belonging to this class are in some instances composed entirely of *cellular tissue;* in other instances, both cells and vessels are present. The *vascular tissue* in the higher orders consists partly of closed spiral and scalariform vessels. Many of them have no true stem nor leaves. The *woody stem*, when present, consists of vascular bundles, which increase in an acrogenous manner. The stem of tree-ferns (which illustrates this class) is unbranched, more or less uniformly cylindrical, hollow in the interior, and marked by the scars of the leaves. *Stomata* occur in the epidermis of the higher divisions. *Leaves*, when present, have frequently no true venation; at other times the venation is forked. There are no *flowers*, and no distinct stamens nor pistils. *Reproduction* takes place in some cases apparently by the union of cells of different kinds (antheridia and pistillidia), by means of which germinating bodies called *spores* are formed. In other cases it is difficult to trace this process of fertilization. The *spore* may be considered as a cellular embryo which has no cotyledons, and germinates from any part of its surface, being heterorhizal.

Sub-class 1. *Amphigamæ, Thallogenes, or Cellulares.*

Acotyledons composed entirely of cellular tissue, having no distinct axis, nor leaves, nor stomata, propagated by means of spores which are often inclosed in asci.

Order 1. Algæ, the Sea-weed Family. Cellular plants found both in salt and in fresh water. Fronds composed of variously formed, often elongated cells, which are either simple or branched filaments, continuous or articulated, separate or combined in different ways, so as to constitute fronds of different kinds. Growth takes place by the division of cells, or by cellular

prolongations, in the form of lateral branches. Reproductive organs consist of spores, which are contained in mother-cells or perispores, or sporocarps. These are sometimes congregated together in receptacles of different sorts. The spores occasionally divide into three or four cells, constituting tetraspores. In addition to spores or sporocarps, there are sometimes round, or clavate, or filamentous cellular bodies present, to which some give the name of antheridia. In some of the simplest Algæ, the whole plant is concerned in producing new individuals by division of the parent cells into two or four. In others there is a union of two filaments, and a passage of certain granular particles (endochrome) from the one to the other, ending in the formation of the spore. This process is termed *conjugation*, and is one of great interest. It has been observed in some of the *Confervaceæ* and *Diatomaceæ.* In certain cases, the terminal cell of the filament is that in which a spore is formed without any conjugation, and in these cases the spore is frequently provided with ciliary processes, which exhibit for a time spontaneous movements; hence called zoospores. In the higher Algæ, the sporocarps containing two, four, or more reproductive cellules, are united together in conceptacles along with filaments containing phytozoa, and called antheridia. In *Characeæ* there are two distinct organs of reproduction.

Sub-order 1. *Diatomaceæ:* inhabiting still waters and moist places; fronds consisting of frustula or fragments, which are either angular or cylindrical, often silicious and brittle (non-silicious in Desmidieæ) united by a gelatinous sort of substance; propagated by the division of parent cells into two halves, which become more or less completely detached, and form new individuals. Conjugation also takes place in some instances, in the same way as in the Confervaceæ.

Sub-order 2. *Confervaceæ:* aquatic plants often of a green color, consisting of one or more cells of a rounded or cylindrical form, united together so as to form an articulated or flat frond. They increase by the merismatic division of cells. Reproduction effected by spores which are formed in the interior of the cells by a change in the arrangement of the granular matter, or by the union of filaments of different plants, a process of conjugation by which granular matter passes from one to the other. *Pl.* 54, *fig.* 34, *a–d; a,* Conferva bombycina; *b*, C. rivularis in various states: *c*, C. flaccida and *d*, C. glomerata.

Sub-order 3. *Florideæ, or Ceramiaceæ:* rose or purple-colored sea-weeds, with fronds formed of a single row of articulated cells, or of several rows of cells combined into a flat expansion; organs of reproduction consist of sporocarps or perispores, intermixed with clavate filaments called antheridia. The sporocarps contain cells or spores often divided into four (tetraspores), and inclosed in conceptacles of various kinds.

Sub-order 4. *Fucaceæ*, or sea-weeds, the sea-wrack tribe: usually growing in salt water: frond consisting of cells which are often united by gelatinous matter, and which sometimes form a broad expansion (a membranous thallus), supported on a stalk; organs of reproduction consist of sporocarps and antheridia, contained in conceptacles opening externally, which are

united in club-shaped expansions or receptacles, situated at the end or margins of the fronds. In germinating, the nucleus bursts the epispore or outer covering of the spore, and sends out filamentous processes. *Pl.* 54, *fig.* 36, Laminaria digitata; *fig.* 37, L. saccharina with cellular tissue and fruit. Fucus vesiculosus (*fig.* 38).

Sub-order 5. *Characeæ:* water plants formed of parallel tubes, which are sometimes incrusted with carbonate of lime; reproductive organs are of two kinds: *a*, a round red globule consisting of eight valves which inclose cells of different kinds, containing granular matter and peculiar spiral filaments or phytozoa; *b*, an oval nucule formed by a large central cell or spore, with five elongated cells wound spirally round it, surmounted by five teeth. Some consider the globule as an antheridium, and as equivalent to an anther.

Order 2. Fungi, the Mushroom Family. The plants belonging to this order consist of cells, sometimes round, sometimes elongated, in the form of filaments, either placed closely together, or separated. They are variable in their consistence, being soft or hard, fibrous or gelatinous, fleshy or leathery. They never contain green gonidia, like Lichens, and they rarely grow in water. There exists a vegetative system, called spawn or mycelium, formed of elongated, simple, or articulated filaments, concealed within the matrix, or expanded over its surface, from which varied forms of fructification proceed. The mycelium occurs either in a filamentous, a membranous, a tubercular, or a pulpy form. The reproductive organs consist of spores or spherical cells (usually four, or some multiple of four), which are either attached to the cellular tissue, and supported often on simple or branched filamentous processes, called sporophores or basidia; or are contained in thecæ, cystidia, or asci, accompanied by bodies called antheridia, or paraphyses; in the latter case the term sporidia is sometimes applied to the spores. The sporophores sometimes end in delicate cells, bearing the spores, and called sterigmata. In the Agarics, or Mushrooms, which are among the best known fungi, there is observed first a roundish protuberance on the mycelium. This swelling is called the volva, or wrapper, and it gradually enlarges, containing in its interior what appears afterwards as the agaric, with its reproductive bodies. When the volva is ruptured the fully-formed agaric is seen, consisting of an upper rounded portion, called the pileus, or cap, supported on a stalk or stipes. On its under surface is situated the hymenium, or the part where the spores are produced, covered at first by a thin membrane, called a veil (indusium or velum), which is ultimately ruptured; and when the rupture takes place at the edge of the pileus, an annulus or ring is left on the stipes. The hymenium, or the part on which the organs of reproduction are placed, consists in the agaric of cellular plates, lamellæ, or gills, radiating from the centre. In other genera of fungi it consists of tubes or solid columns, or fleshy or gelatinous matter. Sometimes the hymenium is on the upper surface of the fungus. Cellular plants, often growing on decaying organic matter, generally very transient, and presenting various colors, and found in all parts of the world.

The plants of this order are remarkable as esculents, as poisonous substances, and as causing great injury to animal and vegetable tissues. It is among these that we find the various mushrooms, some known as furnishing an excellent article of food, others as highly poisonous. It is difficult to indicate any good character by which to distinguish the former from the latter, other than that they generally grow solitary in dry pastures, are rarely high colored, generally white or brownish, seldom show scales, and have brittle flesh. The various moulds which occur on animal or vegetable substances belong to this order. Some fungi are produced on living animals.

Sub-order 1. *Phycomycetes:* Thallus floccose, spores surrounded by a vesicular veil, or sporangium. The principal genera are Phycomyces and Mucor.

Sub-order 2. *Ascomycetes:* Sporidia (spores), contained often in sets of eight in asci or tubes. This sub-order includes the Truffle, Tuber cibarium (*pl.* 54, *fig.* 18).

Sub-order 3. *Hyphomycetes:* Thallus floccose, spores naked, often septate.

Sub-order 4. *Coniomycetes:* Flocci of the fruit obsolete or mere peduncles, spores single, often partitioned, and on more or less distinct sporophores. The principal genera in this sub-order are Ustilago and Uredo, the latter causing the well-known smut and brand. *Pl.* 54, *fig.* 16, Ustilago segetum; *fig.* 17, Uredo phaseoli.

Sub-order 5. *Gasteromycetes:* Hymenium inclosed in a membrane (peridium), spores as in the next sub-order. A species of Bovista one of the principal genera. B. gigantea (*pl.* 54, *fig.* 19) is remarkable for its great size and for the rapidity of its growth; having been known to increase in a single night from the size of a pea to that of a melon. *Pl.* 54, *fig.* 20, represents Morchella esculenta, an edible fungus which is prepared in large quantities in some parts of Europe, by cutting into pieces and drying in ovens.

Sub-order 6. *Hymenomycetes:* Hymenium naked, spores in sets of four, and borne on distinct sporophores. Hydnum auriscalpium and squamatum (*pl.* 54, *fig.* 23). Polyporus perennis (*pl.* 54, *fig.* 21). A species of Polyporus, P. destructor, is one of those Fungi which cause the dry rot. Boletus umbellatus (*pl.* 54, *fig.* 22^a); B. edulis (*fig.* 22^b); Cantharellus cibarius (*fig.* 24); Agaricus fimetarius (*fig.* 25); A. campestris and squarrosus (*fig.* 26); A. procerus (*fig.* 27); and A. muscarius (*fig.* 28). The genus Agaricus contains a great number of species, and includes some that are highly poisonous, as well as others that are perfectly harmless. The common mushroom belongs here.

Order 3. Lichenes, the Lichen Family. Plants forming a thallus, which is either foliaceous, crustaceous, or pulverulent, these different forms depending on the mode in which the cells are developed and combined. The reproductive organs appear on the frond in the form of protuberances of various kinds, consisting of an outer layer of thick-walled roundish cells, more dense than the tissue of the thallus, and of a different color; and of an internal medullary layer of paraphyses and sporangia, lying

perpendicularly to the outer layer. The fructification gradually projects more and more from the surface, and either remains covered with the outer layer, or bursts through it. When it remains closed, there is a nucleus in the centre. When the fructification bursts through the cortical or outer layer, it expands in the form of shield-like disks, called apothecia or patellæ, or linear expansions called lirellæ. Sometimes the cortical matter forms a border round the fructification, at other times it grows up in the form of a stalk, so as to give rise to the podetium. The young thecæ (asci) contain spores, varying from four to eight, or from twelve to sixteen. Occasionally, the spores are in sets of two. Separated cells of the medullary layer, of a green color, called gonidia, or gongyli, are considered as another kind of reproductive organ. There is much uncertainty as to the real character of the spherical or sub-spherical green bodies called gonidia, which are characteristic of true lichens. When separated from the parent structure, they are capable of forming new plants. Lichens are found in all quarters of the globe, adhering to stones, rocks, trees, &c. During their entire growth, they appear to be capable of deriving most of their nourishment from the atmosphere. They have the power of acting on hard rocks, so as to disintegrate them in process of time, and many of them contain much inorganic matter in their composition. They all grow in the air; none are found submersed.

Sub-order 1. *Coniothalameæ:* pulverulent lichens; shields open, without a nucleus, cavity filled with free spores.

Sub-order 2. *Idiothalameæ:* shields closed at first, opening afterwards, containing free spores in a nucleus composed of the gelatinous remains of the paraphytes and sporangia.

Sub-order 3. *Gasterothalameæ:* shields either closed always, or opening by bursting through the cortical layer of the thallus, the nucleus containing the deliquescing or shrivelled sporangia.

Sub-order 4. *Hymenothalameæ:* shields open, discoid permanent, nucleus bearing the sporangia on its surface.

The economical value of some lichens is considerable. Cetraria islandica (*pl.* 54, *fig.* 31), or Iceland Moss, contains a nutritious substance called lichenin. Cladonia rangiferina furnishes the principal winter food of the Reindeer. *Fig.* 29 represents Cladonia pyxidata and verticillata. Parmelia parietina (*pl.* 54, *fig.* 30) contains a yellow coloring matter called parietin. Rocella tinctoria (*fig.* 32) furnishes part of the archil of commerce. *Fig.* 33 represents Usnea florida. The tripe de roche, a nutritious lichen found in the Arctic regions of America, belongs to the genus Gyrophora.

Sub-class 2. *Ætheogamæ or Cormogenæ.*

Order 4. Hepaticæ, the Liverwort Family. Plants having an axis which either bears cellular leaves or is leafless, and is bordered by a membranous expansion or thallus. Stomata are found in the epidermis of some. The reproductive organs are: 1. Antheridia, which are either

imbedded in the frond, or situated on rounded, sessile, and stalked receptacles. 2. Pistillidia, either inclosed in involucres and solitary, or occurring at the edge of the frond, or on the lower side of stalked peltate expansions. Thecæ or developed pistillidia, having no operculum, opening irregularly, or by four valves. Spores often mixed with spiral filaments called elaters. Heterorhizal in germination. Terrestrial plants found in damp places, or inhabiting water; some having a moss-like appearance. They are natives both of cold and warm climates, and are generally distributed over the globe.

Sub-order 1. *Jungermannieæ*, or scale mosses. Frondose or foliaceous plants, terrestrial or on trees. Capsule dehiscent lengthwise into four valves. Jungermannia, the principal genus, is represented by many species: Gymnoscyphus, one of the true Jungermannieæ, is represented in *pl.* 54, *fig.* 43, by G. repens.

Sub-order 2. *Marchantieæ.* Frondose and terrestrial; perennial, growing in wet places, with the fertile receptacle raised on a peduncle, capitate or radiate, bearing pendent calyptrate capsules from the under side, which open variously, not four-valved. Elaters with two spiral fibres. Ex. Marchantia polymorpha (*pl.* 54, *fig.* 44), very common in shaded, moist places.

Sub-order 3. *Anthoceroteæ.* Terrestrial frondose annuals with the fruit protruded from the upper side of the frond; perianth none. Capsule pod-like, single or double-valved, with a free central columella. Elaters none or imperfect. Ex. Anthoceros punctatus (*pl.* 54, *fig.* 42), found on wet slopes and the sides of ditches throughout the United States.

Sub-order 4. *Riccieæ.* Mostly frondose floating little annuals, with both kinds of flowers, and the fruit immersed in the frond. No involucre, perianth, nor elaters. Capsule bursting irregularly. Ex. Riccia.

Sub-order 5. *Monocleæ.* Fruit, solitary capsular, opening laterally by a longitudinal slit. Elaters, mixed with spores. Vegetation, foliaceous or frondiform. Ex. Monoclea.

Order 5. Musci, *Mosses.* Plants having a distinct axis of growth, often giving off branches or innovations; no vascular system. Leaves minute and imbricated, entire or serrated, sometimes with condensed cells, in the form of ribs or nerves. Reproductive organs of two kinds: 1. Antheridia, cylindrical or fusiform stalked bags, containing powdery matter and phytozoa, and mixed with empty jointed filaments or paraphyses. 2. Urn-shaped pistillidia, inclosed at first within a calyptra, which is ultimately carried up with them, leaving often a sheath round the bottom of the fruit stalk. These pistillidia finally become the thecæ, or spore-cases, supported on a stalk or seta, which has leaves at its base, called perichætial leaves; on removal of the calyptra the theca is found to consist of a case with an operculum or lid, which, when it falls off, shows the mouth of the urn, either naked or crowned with a peristome, consisting of one or more rows of teeth (in number four, or a multiple of four), distinct or united in various ways. In the centre of the theca is a columella, and the bag formed between it and the parietes of the theca contains spherical cells, called spores, each of

which divides into four small spores, or sporules, the germinating bodies. In some cases the operculum remains persistent, and the theca opens by four valves. At the base of the theca there is occasionally a fleshy protuberance at one side, called a struma ; or a swelling of the seta, called an apophysis. The calyptra is sometimes split on one side (dimidiate), at other times it is entire or split into short clefts all around its base (mitriform). Between the teeth of the peristome and the edge of the theca an elastic ring or annulus is formed, and occasionally a horizontal septum or epiphragm extends across the mouth of the thecæ. The setæ are sometimes twisted, and so are the teeth of the peristome. Mosses are either erect or creeping, terrestrial or aquatic plants, found in all moist countries, extending from the Arctic to the Antarctic regions. They abound most in temperate climates. They are among the first plants which appear on newly formed islands.

Mosses have been divided into *Pleurocarpi*, those in which the fruit is lateral, and *Acrocarpi*, whese the fruit is terminal. The principal North American sub-orders are: *Fontinaleæ*, *Hypnaceæ*, *Leskeaceæ*, *Neckeraceæ*, *Pterogonaceæ*, *Bryaceæ*, *Meesiaceæ*, *Bartramiaceæ*, *Buxbaumiaceæ*, *Polytrichaceæ*, *Fissidenteæ*, *Leucobryaceæ*, *Dicranaceæ*, *Trichostomaceæ*, *Tetraphideæ*, *Orthotriceaceæ*, *Encalypteæ*, *Grimmiaceæ*, *Weissiaceæ*, *Splachnaceæ*, *Funariaceæ*, *Pottiaceæ*, *Gymnostomaceæ*, *Sphagnaceæ*, *Andræaceæ*, and *Phascaceæ*. Illustrations of one or two species of these sub-orders are furnished by our figures. *Pl.* 54, *fig.* 41, represents Climacium dendroides, one of the Hypnaceæ found in woods on the ground. Sphagnum acutifolium, or Peat-moss (*fig.* 39). This genus furnishes most of the peat found in peat bogs, and employed for various purposes.

ORDER 6. LYCOPODIACEÆ, *the Club Moss Family*. Stems creeping, or corms; annular vessels in the axis. Leaves imbricated, more or less setaceous, sometimes subulate. Thecæ axillary and sessile, one to three celled, opening by valves or indehiscent; often of two kinds, one round, reniform, or crescentic, containing minute powdery matter, and called by some antheridia, though perhaps erroneously; the other of a roundish tetrahedal form, inclosing a cell which produces four spores capable of germinating; the spores are considered by some as equivalent to ovules, and the mother-cell as an ovary or oophoridium. In *Isoetes*, the two kinds of reproductive bodies are imbedded in the substance of the base of the leaf. They are moss-like plants, intermediate between ferns and mosses, and in some respect allied to coniferous plants. They abound in warm, moist, insular climates. There are six genera, and about 200 species. Examples: Lycopodium, Selaginella, Isoetes.

Some of the *Lycopodiums* are emetic and cathartic. The powdery matter in the thecæ is inflammable, and has been used as a substitute for sulphur, under the name of Lycopode, or vegetable brimstone. It is also employed to cover pills, so as to prevent their being acted upon by moisture. Lycopodium squamatum, a Brazilian, and L. lepidophyllum, a Mexican species, coil up into a ball during the dry season, and unroll

during the wet season. Lycopodium clavatum, or common club-moss (*pl.* 54, *fig.* 58.)

ORDER 7. MARSILEACEÆ, OR RHIZOCARPEÆ, the Pepperwort Family. Stem wanting, or a rhizome. Leaves often stalked, with the lamina divided into three or more wedge-shaped pieces. Sometimes the lamina is abortive; vernation circinate. Reproductive organs near the root, or along the petiole, inclosed in an involucre; these organs are of two kinds: 1. Stalked or sessile clustered membranous sacs, containing minute granules, which some consider as pollen: hence the bodies are called anthers. 2. Membranous sacs, containing cells which divide into four, one only of which is developed as a germinating body; the sacs have been called ovule-sacs, and the single developed cell is considered by some as an ovule which is impregnated by the so-called pollen. The thecæ are the bodies from which germination proceeds, creeping or floating plants, found in ditches and pools in various parts of the world, more especially in temperate climates. They are not put to any important use. There are four genera, and upwards of twenty species. Examples: Marsilea, Pilularia, Salvinia. Marsilea quadrifolia (*pl.* 54, *fig.* 47); Pilularia globulifera (*fig.* 45); Salvinia natans (*pl.* 54, *fig.* 46).

ORDER 8. FILICES, OR FERNS. Stem a rhizome, which creeps along or under the surface of the ground, emitting descending roots and ascending fronds (leaves), or which rises into the air so as to form an acrogenous trunk. This trunk (stipe) is of nearly uniform diameter, is hollow in the interior, marked on the hard outer rind by the scars (cicatrices) of the leaves, and contains vascular bundles of woody, dotted, and scalariform vessels, which are inclosed in hard plates, and are arranged in an irregular manner. Sometimes the trunk is dichotomous. The outer fibrous covering is formed by the bases of the leaves, and is thicker at the lower than at the upper part of the stem. The leaves (fronds) have a circinate (gyrate) vernation; their veins are generally of equal thickness, and either simple or dividing in a forked manner, or somewhat reticulated, and occasionally stomata occur. Reproductive organs consisting of spore-cases (thecæ, sporangia), which arise from the veins on the under surface of the fronds, or from their margin. Spore-cases either stalked, with the pedicel passing round them in the form of an elastic ring, or sessile and destitute of a ring. The thecæ sometimes arise from the surface of the frond, while at other times they spring from below, having a cuticular covering in the form of an indusium or involucre. The clusters of thecæ are called sori. The margin of the frond sometimes is folded so as to cover the thecæ, and at times the whole frond is converted into clusters of thecæ. Certain cellular papillæ, on the margin or upper surface of the fronds, have been considered by some as antheridia, each of the cells containing a spiral fibre. Link and others state, that among the young thecæ (pistillidia) filamentous bodies occur, which are equivalent to stamens. Ferns are elegant, leafy plants, occurring chiefly in moist insular climates, and abounding in the tropical islands. In mild and warm climates they occur in the form of large tree-ferns, fifty to sixty feet

high, which give a peculiar character to the landscape. The theca of ferns has been looked upon as a modified leaf, having the same gyrate or circinate development as the frond. Leaves have occasionally been produced in place of thecæ. Ferns having the thecæ on the back of the frond, and furnished with an elastic ring or band, are called dorsiferous and annulate; while those having no thecal ring are exannulate.

Few of the ferns are used medicinally. They are in general demulcent and astringent. Some yield food. The rhizome of *Lastrea Filix mas*, Male-shield-fern, has been used as a vermifuge, especially in cases of tape-worm. It contains starch, gum, saccharine matter, tannin, green fixed oil, and resin. Its properties are ascribed to the fixed oil. The rhizome has been used for tanning, and its ashes contain much carbonate of potash. The syrup called capillaire, and certain pectoral mixtures, are prepared from *Adiantum pedatum* and A. *Capillus Veneris*. The rhizome of *Pteris esculenta* is used as food in Australia, and that of *Marattia alata* in the Sandwich Islands. Many other species of Ferns are esculent. The stems and leaf-stalks of Ferns are often covered with scales and with woody matter. One (*Davalia canariensis*) is called Hare's-foot Fern' on this account; and another (*Aspidium Baromez*) receives the name of Scythian, or Tartarian-lamb, because, when prepared in a particular way, it resembles that animal.

Sub-order 1. *Danæeæ.* Thecæ united in masses, exannulate, opening irregularly by a central cleft. Ex. Danæa.

Sub-order 2. *Ophioglosseæ.* Thecæ collected into a spike, formed at the edges of an altered frond, distinct, exannulate, two-valved. Examples, Ophioglossum, Botrychium. Ophioglossum vulgatum (*pl.* 54, *fig.* 57), very rare in the United States, Botrychium lunaria (*fig.* 56).

Sub-order 3. *Osmundeæ.* Thecæ dorsal, or forming a separate stalked mass (an altered frond), distinct, with a terminal or dorsal ring, more or less incomplete, bursting lengthwise by a regular slit. Examples: Osmunda, or flowering fern, O. regalis (*pl.* 54, *fig.* 55).

Sub-order 4. *Hymenophylleæ.* Thecæ marginal or dorsal, nearly sessile, distinct, annulate, ring horizontal, complete, sometimes oblique, bursting lengthwise. Examples: Hymenophyllum, Trichomanes, Lygodium.

Sub-order 5. *Polypodineæ*, or true Ferns. Thecæ on the back of the frond, pedicellate, or sessile, distinct, annulate, ring vertical, usually incomplete, bursting irregularly and transversely. Aspidium filix mas (*pl.* 54, *fig.* 50): *a*, a frond; *b*, rhizoma; *c*, part of a frond, with sori; *d*, the indusium; *e* and *f*, closed and open thecæ. Adiantum capillus veneris (*fig.* 54 *a*); *b*, portion of the frond with sori; *c*, opened theca. Lomaria spicans (*pl.* 54, *fig.* 53); *a*, a fertile, and *b*, a sterile frond; *c*, a portion of a frond, with sori; *d* and *e* thecæ. Asplenium trichomanes (*fig.* 51 *a*); *b* an opened theca. Scolopendrium officinarum (*fig.* 52); *a*, a frond; *b*, a section magnified, showing two longitudinal sori; *c*, an opened theca. This species is found in the western part of New York. Polypodium vulgare (*fig.* 49); *a*, frond; *b*, rhizoma, with a frond stalk; *c*, portion of frond magnified; *d*, magnified sorus; *e*, theca; *f*, the same

burst open. This species is common in the United States. Ceterach officinarum (*fig.* 49[b]); C leptophylla (*fig.* 48.)

ORDER 9. EQUISETACEÆ, Horse tails. Stem striated, hollow, usually branched, containing much silica in its composition, articulated, the joints being separate, and surrounded by a membranous toothed sheath. There are no true leaves, green-colored branches having a straight vernation, occupying their place. The cuticle exhibits a longitudinal series of stomata. A spiral structure is observed in some of the vessels. Reproductive organs collected into cones; spore-cases (thecæ or sporangia) attached to the lower surface of peltate polygonal scales, and opening by an internal longitudinal fissure; spores in the form of rounded cells, surrounded by two elastic club-shaped, hygrometric filaments, or elaters. Plants, with simple or branched stems, the branches being jointed and placed in whorls at the articulations of the stem, each whorl consisting of as many branches as there are teeth in the sheath. Found in ditches, lakes, and rivers, in various parts of the world.

From the quantity of silicic acid contained in them, some of the species of *Equisetum* are used in polishing woods and in scouring utensils. The spiral filaments which surround their spores are interesting objects under the microscope, exhibiting marked movements according to the moisture or dryness of the atmosphere around them. The stomata are arranged in lines on the cuticle. In *Equisetum hyemale*, often called *Dutch rushes*, the silicious stomatic apparatus is well seen after the action of nitric acid on the stem. There are regular rows of tubercles of a silicious nature, in each of which is a transverse fissure, and at the bottom of the fissure a stoma is placed, with its opening at right angles to that of the tubercle. Each portion of the stoma has a pectinated (comb-like) appearance. The distinctions between the species of Equisetum are founded on the nature of the fertile and barren stems, the number of striæ or furrows, and the number of teeth at the articulations.

There is but a single genus Equisetum, represented in North America by numerous species. One of these is Equisetum hyemale; another is E. limosum (*pl.* 54, *fig.* 59).

SECTION B. PHANEROGAMOUS PLANTS.

Class 2. *Monocotyledones*, Juss. *Endogenæ*, D. C. *Amphibrya*, Endl.

In this great class the plants have a *cellular* and *vascular* system, the latter consisting partly of elastic spiral vessels. The woody *stem* is usually more or less cylindrical, simple, and unbranched. There is no true separable bark, no concentric zones, and no true pith. The *wood* is endogenous, *i. e.* increases by additions which first tend towards the centre, and then curve outwards in an interlacing manner towards the circumference, where much hard ligneous matter is deposited, so as to make the exterior the hardest part. The development of the stem usually takes

place by a single central and terminal bud; occasionally lateral buds are produced, and at times the stem is hollow. The *leaves* are parallel-veined, except in the sub-class Dictyogens, where a kind of reticulation is visible. The parts of the *flower* are arranged in a ternary manner, and they are often petaloid, sometimes scaly or glumaceous. The *ovules* are contained in an ovary, and are fertilized by the application of the pollen to the stigma. The embryo has one cotyledon, and the germination is endorhizal.

Sub-class 1. *Glumaceæ.*

Flowers glumaceous, consisting of bracts or scales, which are imbricated, and not arranged in true whorls. Leaves with parallel veins.

ORDER 10. GRAMINEÆ, the grass family. Flowers usually ☿, sometimes unisexual or polygamous; one, two, or more (some occasionally abortive) are attached to a common axis, and inclosed within bracts, the whole together forming a locusta or spikelet. The outer imbricated bracts are called glumes; they are usually two, sometimes one, rarely wanting, and often unequal. They are either awned (aristate) or awnless (muticous). The bracts inclosed within the glumes are called paleæ or glumellæ; they immediately inclose the stamens, are usually two, the lower being simple, and the upper being formed of two, united by their margins. The innermost set of bracts consist of two or three hypogynous scales (squamulæ, glumellulæ, or lodiculæ), which are either distinct or combined, and are sometimes wanting. Stamens hypogynous, from one to six, or more; anthers dithecal, versatile. Ovary simple; ovule ascending, anatropal; styles, two or three, sometimes united; stigmas feathery or hairy. Fruit a caryopsis. Seed incorporated with the pericarp; embryo lenticular, lying on one side of the farinaceous albumen, near its base; endorhizal in germination. Herbaceous plants, with cylindrical, hollow, and jointed stems, called culms; alternate leaves, with a split sheath and a membranous expansion at the junction of the petiole and blade, called a ligule, the collection of flowers (locustæ) being arranged in spikes, racems, or panicles.

Grasses are found in all quarters of the globe, and are said to form about $\frac{1}{22}$ part of known plants. In tropical regions they sometimes assume the appearance of trees. They generally grow in great quantity together, so as to receive the name of social plants. The order has been divided into numerous sections, founded on the number of flowers in a spikelet, their hermaphrodite, unisexual, or polygamous nature, the number and form of the different sets of bracts, and the nature of their fruit.

This is one of the most important orders in the vegetable kingdom, whether we regard it as supplying food for man, or herbage for animals. To the former division belong the nutritious cereal grains, as wheat (*Triticum*), Oats (*Avena*), Barley (*Hordeum*), Rye (*Secale*), Rice (*Oryza*), Maize (*Zea*), Guinea-corn and Millet (*Sorghum* and *Panicum*): to the latter the various pasture grasses, as Rye-grass (*Lolium*), Timothy-grass

(*Phleum*), Meadow-grass (*Poa*), Cock's-foot-grass (*Dactylis*), Sweet-vernal-grass (*Anthoxanthum*), Fescue (*Festuca*), Dog's-tail-grass (*Cynosurus*), &c. The grains of many other grasses are used for food. *Zizania aquatica* supplies a kind of rice, in the North-western States; *Setaria germanica* yields German millet; *Panicum miliaceum* gives a kind of millet in India, and *Andropogon sorghum* is known as Durra, an Indian grain. *Phalaris canariensis* is the source of the common canary-seed. The cereal grains have been so extensively distributed by man, that all traces of their native country are lost. They seem to be in many instances examples of permanent varieties or races kept up by cultivation. Their grain, or caryopsis, contains a large amount of starch and gluten. Their grasses used for fodder in some parts of the world attain a large size, such as *Anthistiria australis*, the Kangaroo-grass of New Holland, *Tripsacum dactyloides*, the Gama-grass of Mexico, and *Dactylis cæspitosa*, the Tussac-grass of the Falkland Islands. Some of these are five or six feet in height, and are, nevertheless, sufficiently delicate to be used as food for animals. The Tussac has been introduced into England, and thrives well in peaty soils within the influence of the sea-spray. It promises to be a valuable grass in the Hebrides of Scotland.

Sugar is a valuable product obtained from many grasses. It has been produced in Italy from *Sorghum saccharatum*, Sweet Sorgho; in China, from *Saccharum sinense;* in Brazil, from *Gynerium saccharoides;* in the West Indies, from *Saccharum violaceum;* and in many other parts of the world, from *S. officinarum.* The two last are commonly known as sugar-cane, and they are generally considered as varieties of a single species, *Saccharum officinarum*, which is now widely spread over various parts of the world. Six or eight pounds of the saccharine juice of the plant furnish one pound of raw sugar. The recent discoveries of Melsens and others, however, promise a much greater yield than this.

Tribe 1. *Andropogoneæ.* Spikelets bifloral: inferior flowers always incomplete. Paleæ more delicate than the glumes, most often transparent.

This tribe is of great interest from containing the genus Saccharum, or sugar-cane, the principal species of which, S. officinale, is shown on *pl.* 55, *fig.* 8. Here the figures, *a* to *c*, represent the entire plant in various stages; *d* to *g*, pieces of the stalk; and *h*, the flowers; 1*h*, three spikelets with a single flower below. Species of Sorghum furnish broom corn (*S. saccharatum*), guinea corn (*S. cernuum*), and Indian millet (*S. vulgare*).

Tribe 2. *Rotbœlliaceæ.* Spikelets, uni- or bi-floral, rarely trifloral, lodged in an excavation of the axis or rachis, sometimes solitary, sometimes geminate; the one pedicillate, the other subsessile. One flower in all the bifloral spikelets (either superior or inferior) very often incomplete. Glumes one or two, occasionally none, most generally coriaceous. Paleæ membranaceous, rarely bearded. Styles one or two, sometimes very short, or none. Rachis more generally articulated.

Tribe 3. *Hordeaceæ.* Spikelets, several- (rarely one-) flowered, sessile on opposite sides of a zig-zag, channelled and toothed, sometimes jointed

rachis, forming a solitary spike. Glumes horizontal, often side by side in the same plane, sometimes deficient. Paleæ, either pointless or the lower sometimes tipped with a straight awn or bristle.

The principal genera are Hordeum, Secale, Triticum. Hordeum vulgare and disticum constitute common barley. Rye is Secale cereale, and the common wheat is Triticum vulgare.

Tribe 4. *Festucaceæ.* Spikelets several- (few- or many-) flowered, panicled, the uppermost flower often imperfect or abortive. Paleæ pointless, or the lower sometimes tipped with a straight (not twisted nor deeply dorsal) awn or bristle. Stamens one to three. Squamulæ two.

The common cheat, or chess, Bromus secalinus, belongs to this tribe. Also, the orchard-grass, Dactylis glomerata; Rattlesnake-grass, Glyceria canadensis; meadow or spear grass, Poa annua and pratensis; Blue grass, or Wire grass, Poa compressa. False red-top grass, Poa serotina; Fescue grass, Festuca elatior and pratensis. The bamboo, Bambusa arundinacea, is represented in *pl.* 55, *fig.* 10.

Tribe 5. *Avenaceæ.* Spikelets two, several-flowered, panicled, the terminal flower mostly imperfect. Glumes and paleæ, thin and membranaceous, or chartaceous, the lower palea bearing a twisted or bent awn on the back. Stamens three. Squamulæ two.

The common oat, Avena sativa, the skinless oat, A. nuda, and the Hair-grass, Aira cæspitosa and flexuosa, belong to this tribe.

Tribe 6. *Chlorideæ.* Spikelets (rarely one-flowered) usually several-flowered, with the upper flowers imperfect, disposed in one-sided spikes. Glumes persistent, the upper one looking outward. Rachis or axis jointless. Spikes usually racemed or digitate. Stamens two or three.

Here belong the Cord grass, Spartina cynosuroides, and other well-known species of Spartina; the crab grass, Eleusine indica, and the Bermuda grass, Cynodon dactylon.

Tribe 7. *Pappophoreæ.* Spikelets two, many-flowered. Superior flowers abortive. Two glumes and two paleæ, membranaceo-herbaceous. Lower palea, three, meltifid, the divisions subulate awned. The principal genera are Amphipogon, Diplopogon, Triraphis, Pappophorum, Cottea, &c.

Tribe 8. *Arundinaceæ.* Spikelets sometimes unifloral with or without the pedicel of a superior flower, sometimes multifloral. Flowers most frequently covered or surrounded at their base with long, soft hairs, two glumes and two membranaceo-herbaceous paleæ, the glumes often equal or superior to the flowers in length, the inferior palea awned or pointless. Plants generally elevated.

Tribe 9. *Agrostideæ.* Spikelets flowered, perfect, sometimes with the abortive pedicel or rudiment of a second flower above, panicled, or the panicle sometimes contracted into a dense cylindrical spike or head. Stamens not more than three.

Here belong the fox-tail grasses, Alopecurus; Timothy grass, or Herds' grass of New England, Phleum pratense; Rush grass, Vilfa; Bent grass, Agrostis; Red-top, or Herds' grass of Pennsylvania, A. vulgaris; &c.

Tribe 10. *Paniceæ.* Spikelets two-flowered; inferior flower incomplete,

Glumes more delicate than the paleæ, paleæ more or less coriaceous or chartaceous, most frequently awnless; the lower concave. Caryopsis compressed parallel with the embryo.

Tribe 11. *Phalarideæ* (of Kunth). Spikelets hermaphrodite, polygamous, rarely monœcious, sometimes one-flowered, with or without the rudiment of another superior flower; sometimes two-flowered, the two flowers hermaphrodite or male; sometimes two- or three-flowered, terminal flower fertile, the others incomplete. Glumes most generally equal. Paleæ or glumelles often lustrous, and hardened with the fruit. Styles or stigmata most generally elongated.

The principal genera are Alopecurus, Phleum, Holcus, Phalaris, Anthoxanthus, Crypsis, &c. Zea mays or Indian corn likewise belongs to this tribe.

Tribe 12. *Oryzeæ:* the Rice Tribe. Spikelets unifloral, glumes frequently wanting, or two to three floral; one or two lower flowers unipaleaceous, neutral; the terminal flower fertile. Paleæ stiffly chartaceous; stamens one to six.

It is in this tribe that we find the genus Oryza, one species of which, O. sativa, furnishes the rice of commerce. This is represented in *pl.* 55, *fig.* 9, where *a* to *c* exhibit an entire plant cut into three parts; *d* is the mountain rice, by some considered as a separate species under the name of O. montana; *e*, the flower; *f*, two grains of the mountain rice; *g*, a caryopsis of the common rice; *h* to *k*, hulled grains; *l*, a caryopsis of the common rice. The original abode of the rice plant is to be found in Southern Asia, thence having been transplanted to various parts of the globe. There are three varieties of rice known in commerce: 1, the Egyptian rice, white and coarse grained, often mixed with salt to keep off insects; 2, the American rice, principally from the Carolinas, like the preceding, but clearer, and preferred above all the other varieties; 3, the Italian rice, generally shorter and thicker than the rest, with furrowed grains. Other genera are Leersia and Zizania, the latter furnishing the wild rice of the northern lakes (L. aquatica).

Order 2. Cyperaceæ, the Sedge Family. Flowers hermaphrodite or unisexual, generally without a perianth. Each flower furnished with a solitary bract (glume or scale). These bracts are imbricated upon a common axis, and the lowermost are often empty. Occasionally they inclose two or three opposite membranous bracts or glumes. (In the female flower of Carex, the two inner bracts receive the name of Perigynium.) Stamens hypogynous, definite, one to twelve; anthers dithecal, innate. Ovary one-celled, often surrounded by hypogynous bristles (setæ), which are probably abortive filaments; ovule erect, anatropal; style single, two- to three-cleft; stigmas undivided, sometimes bifid. Fruit a crustaceous or bony achænium or nut; embryo lenticular, inclosed within the base of fleshy or farinaceous albumen; plumule inconspicuous. Grass-like herbs with fibrous roots. Their stems are solid, often without joints, sometimes creeping, frequently angular. The leaves are narrow, and their sheaths are entire, not slit. They are found in all quarters of the globe, and in various localities, from

the sand on the sea-shore to the tops of the mountain. Many of them occur in marshy ground.

None of the plants of the order possess important medicinal qualities. The creeping stems of *Carex arenaria*, *disticha*, and *hirta*, are diaphoretic and demulcent, and have been used in medicine under the name of German Sarsaparilla. *Papyrus antiquorum* is the Papyrus of the Nile, the cellular tissue of which was used in the manufacture of paper. The species of *Eriophorum* are called cotton-grass, on account of the woolly-like substance which is attached to the base of the ovary. Some species of *Cyperus* have tubers at the lower part of their stems, which are used as food. The roots of *Cyperus longus* have been used as bitter and tonic remedies, while those of *C. odoratus* are aromatic. Some species of *Scirpus* are used for making chair bottoms. Some of the *Carices*, with their creeping stems, tend to bind together the loose sand on the sea-shore.

Tribe 1. *Cariceæ.* Flowers monœcious in the same (androgynous) or separate spikes, sometimes diœcious; proper perianth none. Achenium inclosed in a sac (composed of two united inner scales, *perigynium*), lenticular or triangular. The most important genus in this tribe is Carex, represented by a vast number of species.

Tribe 2. *Elyneæ.* Flowers mono-diclinous, perigone, none or multisetaceous. setæ glabrous or soft; caryopsis trigonal, bearing on its summit the base of the style which there forms a kind of rostrum or beak. Examples: Trilepis. Elyna, Kobresia.

Tribe 3. *Sclerieæ.* Flowers monœcious; the fertile spikes one-flowered, the staminate several-flowered. Example: Scleria or nut rush.

Tribe 4. *Rhynchosporeæ.* Flowers hermaphrodite or polygamous, few or one-flowered: perigone provided with stiff setæ, ciliated or plumose; caryopsis cartilaginous or crustaceous. There are two sub-tribes, one of which has Rhynchospora for its type, the other Schœnus.

Tribe 5 *Cladieæ.* Flowers hermaphrodite, perigone none; caryopsis bony, thick, very hard, often expanded at the summit, naked or surmounted by the base of the style. Ex. Cladium, Lamprocarya, &c.

Tribe 6. *Chrysitricheæ.* Flowers androgynous, monocarpous: perigone proper, without a disk; caryopsis crustaceous, globular, wrinkled at the summit. Ex. Chrysithrix and Lepironia.

Tribe 7. *Hypolytreæ.* Flowers perfect: the scales, many-ranked, each covering a flower provided with its own (one to four) proper scale-like bractlets. True perianth none. Examples: Lipocarpha, Platylepis, Hemicarpha. Diplasia.

Tribe 8. *Fuireneæ.* Flowers perfect: the scales many-ranked (regularly imbricated on all sides), each covering a naked flower. Perianth, chiefly double, viz., of three ovate scale-like sepals on claws, alternating with three small bristles. There are three sub-tribes: 1. Melanocranideæ; 2. Hemichlæneæ; and 3. Ficinieæ. Fuirena is the type of the latter.

Tribe 9. *Scirpeæ.* Flowers perfect: the scales regularly several-ranked. all, or all but the lowest, covering a naked flower. Perianth of bristles, or

hairs, or none. Ex. Isolepis, Scirpus, Eriophorum; Eriophorum angustifolium (*pl.* 55, *fig.* 6), *a*, flower, *b*, fruit.

Tribe 10. *Cypereæ.* Flowers hermaphrodite, few or many: generally from one- to three-flowered; perigone rarely present, setaceous; caryopsis crustaceous, compressed, sometimes mucronate, rarely cuspidate. The most celebrated species of this tribe is the Papyrus antiquorum, or the plant furnishing the papyrus of the ancients (*pl.* 56, *fig.* 9). Another well-known genus is Cyperus. C. officinalis (*pl.* 55, *fig.* 7) *a*, the lower part of the stalk; *b*, the upper part; *c*, a scale; *d*, the reproductive apparatus.

Sub-class 2. *Petaloideæ.*

Flowers having usually a perianth consisting either of verticillate leaves, which may sometimes be separated into calyx and corolla, and are often colored (petaloid), or of a few whorled scales. Occasionally the perianth is abortive.

a. Flowers Incomplete, often Unisexual, without a Proper Perianth, or with a Few Verticillate Scales.

Order 12. Restiaceæ, or Eriocaulonaceæ, the Restia, or Cord-Rush Family. Flowers frequently unisexual, perianth glumaceous, sometimes none. Stamens definite, perigynous when two or three in number opposite the inner glumes; anthers usually one-celled. Ovary one or more celled, sometimes composed of several carpels; ovules solitary, pendulous; styles and stigmas two or more. Fruit capsular, or nucumentaceous. Seeds pendulous: embryo lenticular, outside mealy albumen, remote from the hilum. Herbs or undershrubs, with narrow, simple leaves, or none, naked or sheathed columns, and spiked or capitate bracteated flowers. They are found chiefly in America and New Holland. They have few properties of importance. The tough, wiry stems of *Willdenovia teres*, and some *Restias*, are used for making baskets and brooms. *Eriocaulon septangulare* is a native of Britain and of North America.

Order 13. Naiadaceæ, or Potameæ, the Naias, or Pondweed Family. Flowers hermaphrodite or unisexual. Perianth of two or four herbaceous or scaly pieces, often deciduous, sometimes none. Stamens definite, hypogynous. Ovary free, of one or more carpels; ovule solitary; style one or none; stigma entire, rarely two- to three-parted. Fruit dry, one-celled, usually indehiscent. Seed solitary, erect, or pendulous, exalbuminous: embryo straight or curved, usually with a lateral slit for the plumule; radicle large. Plants living in fresh and in salt water, having cellular leaves with parallel veins and inconspicuous flowers. They are found in various parts of the world. They have no properties of importance. *Zostera marina* is used in the dried state for stuffing mattresses, and has been recommended for hospitals. There are nineteen known genera, and upwards of seventy

species. Ex. Naias, Zannichellia, Potamogeton, Ruppia, Zostera, all of which have North American representatives.

Potamogeton natans, or common pondweed, is abundant along the shores of still waters (*pl.* 55, *fig.* 1), *a*, the plant; *b*, a flower; *c*, a sepal seen from behind; *d*, the same with the stamen from the inside; *e*, the four pistils; *f*, a fruit; *g*, longitudinal section of the same. *Zostera marina* (*fig.* 3), *a*, a plant reduced; *b*, the upper part of a fertile branch; *c*, an opened spatha with the inclosed spadix; *d*, the lower part of a fruit-bearing spadix in the spatha; *e*, an anther from behind; *f*, ovary; *g*, ovary opened, showing the seed; *h*, the seed; *i*, section of the seed showing the embryo.

ORDER 14. AROIDEÆ, the Arum Family. Flowers generally unisexual, rarely bisexual, inclosed within a spatha, and usually on a spadix, having male flowers at its upper part, female below, and abortive flowers between them. Perianth either 0, or in the ☿ flowers rudimentary and scaly. Stamens definite or 00, hypogynous; anthers extrorse. Ovary free, one- to three- or more-celled; ovules solitary or numerous; style short or 0; stigma simple. Fruit succulent or dry, indehiscent, uni- or pluri-locular: seeds one or several; embryo in the axis of fleshy or mealy albumen, sometimes with a lateral cleft for the plumule; radicle usually next the hilum. Herbaceous or shrubby plants, often with tubes or creeping rhizomes, leaves sheathing at the base, and having parallel or branching veins. They occur in dry and marshy places, and in lakes in various parts of the world, abounding in the tropics.

This order has been variously subdivided; the most convenient division for our purpose, however, is into four sub-orders.

Sub-order 1. *Pistieæ* (*Lemnaceæ*) or Duckweeds. Flowers ♂ ♀ naked, inclosed in a spatha without a spadix, ovary one-celled, ovules two or more, fruit membranous or capsular. Examples: Pistia, and Lemna or duck-weed.

Sub-order 2. *Acoreæ*. Flowers ☿ having usually a scaly perianth, arranged on a spathaceous spadix, ovules one or more, fruit a berry. Examples: Symplocarpus (S. fœtidus or skunk cabbage); Orontium (O. aquaticum, never wet, or Golden club); and Acorus. A species of this latter genus, Acorus calamus, found both in Europe and America, furnishes the calamus or sweet flag, so much sought after by boys, and a favorite food of the muskrat (Fiber zibethicus). This specious of Acorus is shown in *pl.* 55, *fig.* 4; *a*, an entire plant; *b*, a spadix; *c*, a flower from above; *d*, the same from below; *e*, an unripe fruit; *f*, the same in vertical and *g* in transverse section; *h*, a leaf cut across (right hand of the plate).

Sub-order 3. *Typhineae.* (Typhaceae). Bulrushes or Cat-tails. Marsh herbs, with nerved and linear sessile leaves, and monœcious flowers on a spadix or in heads, destitute of proper floral envelopes. Fruit nut-like when ripe, one-seeded. Seed suspended, anatropous; the embryo straight in copious albumen. There are but two genera, Sparganium and Typha. Typha latifolia is the common cat-tail of the swamps (*pl.* 55, *fig* 5); *a*, the spadix with its spatha; *b*, a cross-section of the male spadix; *c*, a male flower.

Sub-order 4. *Arineæ.* Naked flowers with a spadix and spatha, ♂ ♀, anthers sessile, ovules several, fruit succulent, seeds pulpy, Arum triphyllum is the well known Indian Turnip; A. maculatum, or the European Wake Robin, is represented in *pl.* 55, *fig.* 2; *a*, the entire plant, *b*, the spadix with its flowers; *c*, anther; *d*, the disk; *e*, an ovary; *f*, the lower part of the spadix with fruit; *g*, one of the fruit cut transversely; *h*, a seed in longitudinal section. Other genera are Peltandra, Calla, Collocasia, Calladium.

Order 15. Pandanaceæ or Screw Pines. Flowers unisexual or polygamous, covering the whole of the spadix. Perianth 0, or a few scales. Male flowers: stamens numerous; filaments with single anthers, which are two- to four-celled. Female flowers: Ovaries one-celled, united in parcels; ovules solitary or numerous, anatropal; stigmas sessile, equal to the carpels in number. Fruit either fibrous drupes collected into parcels, or berries. Seeds solitary in the drupes, numerous in the berries; embryo at the base of fleshy albumen; radicle next the hilum. Trees or bushes, sometimes with adventitious roots, long, imbricated, amplexicaul leaves, usually with spiny margins and backs. Natives of tropical regions.

The flowers of some of the plants are fragrant, and their seeds are sometimes used as food. The juice has in some instances astringent properties. The species of *Pandanus* are remarkable for their aerial roots, with large cup-like spongioles. These roots are sent out regularly from all parts of their stems, and appear like artificial props. Their spermoderm has numerous raphides. Their leaves are arranged in a spiral manner in three rows, and in their aspect they have some resemblance to those of the pine-apple, hence the name screw-pine. *Pandanus candelabra* is the chandelier-tree of Guinea, and is so called on account of its mode of branching.

This order is divisible into two sub-orders.

Sub-order 1. *Cyclantheæ*, with fan-shaped or pinnate leaves. Flowers most generally provided with a perianth. Examples: Carludovica, Cyclanthus, Nipa, Wettinia.

Sub-order 2. *Eupandaneæ.* Leaves simple or undivided, perianth none. Examples: Pandanus, Freycinetia.

b. Perianth free, Ovary superior, Flowers usually hermaphrodite.

Order 16. Butomaceæ, the Flowering-rush Family. Perianth of six parts, in two verticils; outer usually herbaceous; inner petaloid. Stamens definite, or 00, hypogynous. Ovaries three, six, or more, distinct or united, one-celled; ovules 00; stigmas simple, as many as the carpels. Fruit consisting of several follicles, which are either distinct and beaked, or combined. Seeds 00, minute, attached to the whole inner surface of the pericarp, exalbuminous; embryo often curved like a horse-shoe; radicle next the hilum. Aquatic plants, often lactescent, with parallel-veined leaves, and frequently umbellate flowers. They are chiefly found in northern countries, and some of them have acrid and bitter properties. The principal genera are Butomus, Limnocharis, and Hydrocleis.

Order 17. Alismaceæ, the Water plantain Family. Perianth in six

divisions and two verticils; outer whorl usually herbaceous; inner usually petaloid; sometimes the perianth is wanting. Stamens definite or 00, hypogynous; anthers introrse or extrorse. Ovaries, three, six, or more, distinct or united; ovules erect or ascending, solitary or in pairs. Styles and stigmas equal to the number of carpels. Fruit of several dry, indehiscent carpidia. Seeds from one to two in each carpel, exalbuminous, embryo straight, or curved like a horse-shoe; radicle next the hilum. Plants growing in flowing or stagnant water, usually with a creeping rhizome, parallel-veined leaves, and hermaphrodite or unisexual flowers. Natives both of tropical and temperate regions.

Sub-order 1. *Juncagineæ.* Calyx and corolla colored alike (greenish). Seed anatropous, with a stright embryo. Leaves petiole-like, without a blade. Examples: Triglochin, Scheuchzeria.

Sub-order 2. *Alismeæ.* Calix green and persistent. Corolla white and deciduous. Seed campylotropous; embryo bent double, or hook-shaped. Leaves commonly furnished with a blade. Examples: Alisma, or water-plantain, Echinidorus, and Sagittaria. Sagittaria variabilis (sagittifolia) is distributed throughout North America; the rhizomes are used as food by the Oregon Indians.

Order 18. Commelynaceæ, the Spider-wort Family. Perianth in two verticils; outer (calyx) herbaceous and tripartite; inner (corolla) petaloid, tripartite, or trifid. Stamens six or fewer hypogynous, some of them occasionally abortive or deformed; anthers introrse. Ovary three-celled; ovules few in each cell; style one; stigma one. Fruit a two- or three-celled, two- or three-valved capsule, with loculicidal dehiscence. Seeds often in pairs, with a lateral or linear hilum; embryo pulley-shaped, antitropal in a cavity of fleshy albumen, remote from the hilum. Herbs with flat narrow leaves, which are usually sheathing at the base. Natives chiefly of warm climates. Some have fleshy rhizomes, which are used for food.

Examples: Mayaca, Tradescantia (T. virginica, or spider-wort), and Commelyna. C. tuberosa, from Mexico (*pl.* 57, *fig.* 3), *a*, the stalk with leaves and flowers; *b*, the tuberous root; *c*, the calyx with the stamens and pistil; *d* and *e*, stamens; *f*, the pistil; *g*, the stigma.

Order 19. Palmæ, the Palm Family. Flowers bisexual, or unisexual, or polygamous. Perianth six-parted, in a double row; three outer (calyx) fleshy, or leathery and persistent; three inner (corolla) often larger, and sometimes deeply connate. Stamens six, rarely three, sometimes 00, inserted into the base of the perianth. Ovary free, one- or three-celled, usually composed of three carpels, which are more or less completely united; ovules from one to three. Fruit drupaceous, or nut-like, or baccate, often with a fibrous covering. Seed with cartilaginous or horny albumen, which is often ruminate, or furnished with a central or lateral cavity; embryo small, cylindrical, or flat in the cavity of the albumen, remote from the hilum. Arborescent plants, with simple, rarely branched trunks, marked with the scars of the leaves, which are terminal, pinnate, or fan-shaped, with plicate vernation, and parallel simple veins, and often spiny

petioles. Flowers on a terminal, often branched spadix, inclosed in a one- or many-valved spatha. Natives of tropical regions chiefly, and imparting to them much of their botanical physiognomy. Most of them have unbranched stems, attaining sometimes a height of 180 feet, and sending out clusters of large leaves, from the axils of which bunches of flowers proceed. Although the flowers are small, still the infloresecence, taken collectively, has often a most imposing aspect. Humboldt describes their effect on the landscape in glowing colors, and Martius has illustrated the order by splendid delineations. Linnæus called them the Princes of the vegetable kingdom. Lindley states that there are seventy-three known genera, and four hundred species; but this estimate probably falls short of the total amount, for much still remains to be done in the elucidation of the species. They have been divided by Martius into various tribes, depending chiefly on the nature of the ovary, ovules, and fruit; and sections are formed according as the leaves are pinnate or flabelliform, and the stems are spiny or not.

The species of this order are eminent not only for their beauty but for their utility. Distributed over the tropical portions of the entire globe, they in many cases form the entire dependence of whole tribes. Every portion of these plants is applied to some important end; water-pipes are made of the hollow trunks, while those that are more solid furnish an excellent building material of great strength. Canes, umbrella and fan handles, and numerous other articles, are made of palm-wood. The density of palm-wood varies greatly, the lightest being that of the Date Palm (0.3963), and the heaviest that of Astrocaryum murumuru (1.1380). The progress of age causes the deposit of large quantities of starch in the form of fine powder in the trunks of some palms. This, the sago of commerce, is obtained chiefly from the species of Metroxylon, as also of Caryota, Borassus, Arenga, Phœnix, &c. The juice of many Palms contains a large quantity of sugar (Jagery) which may be collected for economical purposes, or else used in the manufacture of various arracks and other intoxicating liquors. A substance called *Toddy* is obtained from the spathes of Cocos nucifera, of medicinal value in tropical constipation.

The leaves of the large palms are used in covering houses, the petioles for various purposes. The fruit of various species is an important article of alimentation; the date is derived from Phœnix dactylifera; the common cocoa-nut from Cocos nucifera; the double cocoa-nut from Lodoicea seychellarum. The fruit of certain species furnishes palm oil, that from Elais guineensis being distinguished from the rest by the presence of palmic acid. Medicinal substances are, catechu from the betel nut or fruit of Areca catechu (to be distinguished from the true catechu, which is derived from a species of Mimosa); dragon's blood from Calamus draco; bdellium from Hyphæne thebaica. Wax also is furnished by several species, occurring in the form of a thin coating on the leaves or trunk. The principal wax producing palm is Copernica cerifera, a Brazilian species yielding the carnauba wax. Others are Ceroxylon andicola, Ceratolobus glaucescens, &c. Finally, the fibres of some species yield valuable textile materials, and

the hard albumen of the fruit of Phytelephas macrocarpa, known as vegetable ivory, is used for the same purposes as true ivory.

The tribes into which the Family of Palmæ is divided are: 1. *Arecineæ.* Examples: Euterpe, Oreodoxa, Areca, Morenia, Iriartia, Caryota, &c. 2. *Lepidocaryineæ*, of two subdivisions, one with pinnate leaves embracing Calamus, Sagus, Metroxylon, &c., the other with the leaves fan-shaped, Mauritia and Lepidocaryum. 3. *Borassineæ;* (*a*, Leaves pinnate) Borassus, Lodoicea, Latania, Douma, &c.; (*b*, leaves flabelliform) Vouay, Iguanura, Geonoma, &c. 4. *Coryphineæ;* sub-tribe *a.* *Sabalineæ*, Corypha, Brahea, Copernicia, Sabal, Chamærops, &c.; sub-tribe *b.* *Phœnicineæ.* Examples: Phœnix. 5. *Cocoineæ.* Examples: Desmoncus, Guilielma, Acrocomia, Astrocaryum, Attalea, Elæis, Cocos, Maximiliana, Syagrus, &c.

Pl. 56, *fig.* 2. Phœnix dactylifera or date palm: *a*, spadix; *b*, male flowers; *c*, female flowers; *d* (*e* in the plate), a single female flower; *e*, anther; *f*, a male flower; *g*, the three pistils; *h*, the fruit; *i*, a section of fruit.

Pl. 56, *fig.* 1. Cocos nucifera or cocoa-nut; *a*, pinnula; *b*, portion of the spadix in its spatha; *c*, portion of the spadix; *d*, the nut; *e*, the same in longitudinal sections excepting the nucleus; *f*, *g*, *h*, various parts of the fruit; *i*, the germ; *k–s*, various parts of the flowers.

Pl. 56, *fig.* 7. Areca catechu, or areca palm. *Fig.* 3. The sago palm, Sagus farinifera; *a*, a portion of the spadix; *b*, a fruit in its natural position; *c* and *d*, the fruit in transverse and longitudinal sections; *e* and *f*, male flowers; *g–m*, female flowers.

Order 20. Juncaceæ, the Rushes. Perianth six-parted, more or less glumaceous. Stamens six, inserted into the base of the segments, sometimes three, and opposite the outer segments; anthers two-celled, introrse. Ovary one- to three-celled; ovules 1, 3, or many in each cell, anatropal; style one; stigmas generally three, sometimes one. Fruit a three-valved capsule, with loculicidal dehiscence, sometimes indehiscent. Seeds with the testa neither black nor crustaceous; embryo very minute, near the hilum, within fleshy or cartilaginous albumen. Herbs with fasciculated or fibrous roots, hollow, grooved, or flat leaves, with parallel veins. They are natives chiefly of the colder regions of the globe. Many species of *Juncus* are used for making the bottoms of chairs, mats, &c., and the central cellular tissue forms the wicks of candles. There are fourteen known genera, and upwards of two hundred species. Examples: Juncus, Luzula, Narthecium, Astelia.

Luzula pilosa or wood rush (*pl.* 57, *fig.* 2), an American species; *a*, the plant in two pieces; *b*, an open flower; *c*, the fruit; *d*, the fruit opened showing the seeds; *e*, a single seed.

Order 21. Xyridaceæ, the Yellow-eyed Grass Family. Perianth six-parted, in two verticils; the outer glumaceous, the inner petaloid. Stamens six, three fertile, inserted into the claws of the inner perianth; anthers extrorse. Ovary single, one-celled; ovules 00, orthotropal, attached to parietal placentas; style trifid; stigmas obtuse, multifid or undivided. Fruit a one-celled, three-valved capsule. Seeds numerous; embryo on the outside of mealy albumen, remote from the hilum. Herbs, having a sedge-like aspect,

with radical leaves, equitant and sheathing at the base, and scaly heads of flowers. Natives chiefly of tropical regions, having no important properties. There are about six genera and seventy species. Examples: Xyris, Abolboda, Philydrum. Four or five species of the typical germs Xyris are known in the United States.

ORDER 22. PONTEDERIACEÆ, the Pond-weed Family. Perianth tubular, colored, six-parted, more or less irregular; æstivation circinate. Stamens three to six, perigynous; anthers introrse; ovary free, or slightly adherent, three-celled; ovules numerous, anatropal; style one; stigma simple. Fruit a three-celled, three-valved capsule, with loculicidal dehiscence. Seeds 00, attached to a central axis; testa membranous; hilum small; embryo straight, in the axis of somewhat mealy albumen; radicle next the hilum. Aquatic or marsh plants with sheathing, parallel-veined leaves, which are sometimes cordate or sagittate, and have inflated petioles. The flowers are spathaceous. They are natives of North and South America, East Indies, and Africa. Their properties are unimportant. There are six genera, according to Lindley, and thirty species. The principal genera of the United States are Pontederia, Heteranthera, Schollera, and Syena.

ORDER 23. GILLIESIACEÆ, the Gilliesia Family. Perianth six-parted, sometimes five-parted by cohesion of two of the pieces, in a double row; the outer, petaloid and herbaceous; the inner, smaller and more colored; æstivation twisted. Stamens in a double series; outer whorl sterile, in the form of a six-toothed urceolate body, or of scale-like bodies, one of which forms a sort of labellum; inner whorl of six stamens, of which three are sometimes sterile. Ovary superior, three-celled; style one; stigma simple. Fruit a three-celled, three-valved capsule, with loculicidal dehiscence. Seeds numerous, attached to the axis; spermoderm black and brittle; embryo curved in the midst of fleshy albumen. Herbs with tunicated bulbs, grass-like leaves, and umbellate spathaceous flowers. Natives of Chili. Examples: Gilliesia, Miersia.

ORDER 24. MELANTHACEÆ, the Colchicum Family. Perianth petaloid, in six pieces, which are sometimes slightly coherent, usually involute in æstivation. Stamens six; anthers extrorse. Ovary three-celled; ovules numerous; style three-parted; stigmas three, undivided. Fruit a three-celled capsule, with septicidal or loculicidal dehiscence. Seeds with a membranous spermoderm; albumen dense, fleshy; embryo very minute. Plants with bulbs, tubers, or fibrous roots, having parallel-veined leaves, sheathing at the base. The flowers are sometimes polygamous. They are natives of various parts of the globe, but are most abundant in northern countries.

Sub-order 1. *Uvularieæ*, Bellworts. Perianth early deciduous, sepals distinct, petaloid. Styles united into one at the base or throughout. Fruit a three-celled few-seeded berry or loculicidal pod. Stems from small perennial root stocks and fibrous roots, forking, bearing ovate or lanceolate, membranaceous, sessile or clasping leaves, and perfect flowers; peduncles solitary or one-flowered. Examples: Uvularia, Prosartes, Streptopus.

Sub-order 2. *Colchiceæ*. Rhizome bulbous, dehiscence of pod septicidal. Of the typical genus Colchicum, the European species, C. autumnale (*pl.*

57, *fig.* 4), known as Meadow saffron or autumnal crocus, has important medicinal properties. The various parts of the plant referred to by the letters will be readily intelligible.

Sub-order 3. *Melanthieæ.* Perianth mostly persistent or withering away; the sepals distinct, or the claws rarely united. Styles three, separate. Fruit a three-celled, three-partible or septicidal pod. Flowers frequently unisexual. Rhizome fibrous. The most important genera are Melanthium, Veratrum, Helonias, Tofieldia, &c. Cevadilla, an important medicinal substance, is obtained from Helonias officinalis, and Veratrum sabadilla. Veratrum album furnishes the white hellebore of the ancients; this, with some other species of Veratrum, yields veratrine. *Pl.* 57, *fig.* 5, Veratrum album.

Order 25. Liliaceæ, the Lily Family. Flowers usually bisexual. Perianth colored, in two rows, regular, with six divisions. Stamens six, perigynous, inserted into the segments of the perianth; anthers introrse. Ovary free, three-celled; ovules 00; style one; stigma simple or three-lobed. Fruit three-celled, either succulent or dry and capsular. Seeds numerous, packed one above the other in one or two rows; embryo in the axis of fleshy albumen. Herbs, shrubs, or trees, with bulbs, or tubers, or arborescent stems, or rhizomes; leaves not articulated, usually narrow, with parallel veins. They are found both in temperate and tropical climates. In warm regions some of them are arborescent, as in the case of Dracæna; others are very succulent, as species of Aloe.

Sub-order 1. *Aphyllantheæ.* Habit rush-like; with membranous imbricated bracts. The species of the sub-order characterize the vegetation of New South Wales.

Sub-order 2. *Aloineæ* or Aloes tribe. Stem usually developed, arborescent, leaves succulent. Examples: Sanseviera, Aloe, and Yucca. The drug called Aloes, is the thickened juice of various species of Aloe, as A. vulgaris, spicata. socotrina, &c. *Pl.* 56, *fig.* 6, *a–d*, Aloe arborescens.

Sub-order 3. *Asparageæ.* Fruit a few-seeded berry, two-to three-celled; seeds amphitropous, orthotropous, or anatropous. Stem usually fully developed, arborescent, in some cases branched, leaves often coriaceous and permanent. Examples: Asparagus, Dracæna, Smilacina, Clintonia, &c. *Pl.* 57, *fig.* 1, Dracæna draco, a species of Dracæna from the East Indies, from which dragon's blood is obtained; *a*, a very old tree; *b*, extremity of a branch with flowers; *c*, a flower on a larger scale; *d*, expanded flowers; *e*, a stamen; *f*, pistil; *g*, branch with fruit; *h*, a seed; *i*, vertical section of do. A species from Brazil, D. brasiliensis, is figured on *pl.* 56, *fig.* 5, *a–e*.

Sub-order 4. *Convallarieæ*, Lily of the valley tribe. Stem developed as a rhizome or tuber. Ex. Convallaria.

Sub-order 5. *Anthericeæ.* Not bulbous, roots fascicled, or fibrous, leaves not coriaceous, nor persistent. Examples: Asphodelus, Anthericum.

Sub-order 6. *Scilleæ.* Bulbous, with the testa black and brittle. Scape simple. Perianth six-sepalled or six-parted. Examples: Ornithogalum, Scilla, Allium. The bulb of Scilla esculenta or Squamash, is eaten by the Western Indians. Allium sativum is garlic; A. cepa the onion.

Sub-order 7. *Hermerocallideæ.* Bulbous plants, with a tubular perianth;

testa pale and soft. Examples: Hemerocallis and Phormium. A species of this latter genus, P. tenax, furnishes the New Zealand flax, eminent for its strength of fibre (*pl.* 57, *fig.* 9, *a–d*).

Sub-order 8. *Tulipeæ.* Fruit a many-seeded, three-celled, loculicidal pod. Seeds anatropous. Perianth six-leaved; segments scarcely adherent in a tube; testa pale and soft. Examples: Tulipa, Lilium, Erythronium, Methonica, Fritillaria. Many species of this sub-order are remarkable for their beauty, as the Tulip, the Lily, Crown Imperial, &c. Erythronium dens-canis a European species (*pl.* 57, *fig.* 7, *a* to *e*). Fritillaria imperialis or Crown Imperial (*pl.* 57, *fig.* 6, *a–g*).

c. Perianth Adherent; Ovary Inferior; Flowers usually Hermaphrodite.

Order 26. Bromeliaceæ, the Pineapple Family. Perianth tubular, six-divided, in two verticils; outer whorl (calyx) persistent, more or less adherent to the ovary; inner petaloid, marcescent or deciduous, with imbricated æstivation. Stamens six, inserted into the base of the segments of the perianth; anthers introrse. Ovary either free or partially adherent, three-celled; ovules 00, anatropal; style single; stigma three-lobed or entire, often twisted. Fruit capsular or succulent, three-celled. Seeds 00; embryo minute, curved or straight, lying in the base of mealy albumen; radicle next the hilum. Stemless or short-stemmed plants, with rigid, channelled leaves, which are often spiny at the margin, and are covered with scurfy matter. Natives chiefly of the warm parts of America.

The plants of this order are all more or less epiphytic, or able to grow without attachment to the soil. Tillandsia usneoides, or Spanish moss, is found along the southern coast of the United States, growing or suspended from trees, in large quantities. T. utriculata collects water in the hollowed bases of its leaves. The well-known Pineapple (Ananassa sativa) belongs here. The tribes are four.

Tribe 1. *Ananasseæ.* Ovary inferior, fruit fleshy, stamens six. Examples: Ananassa, Bromelia, Æchmea, Billbergia, Hohenbergia.

Tribe 2. *Vellozieæ.* Ovary inferior, fruit capsular, stamens six or more. Examples: Barbacenia, Vellosia.

Tribe 3. *Pitcairnieæ.* Ovary semi-inferior. Examples: Brocchinia, Pitcairnia.

Tribe 4. *Tillandsieæ.* Ovary free. Examples: Tillandsia, Bonapartea, Navia, Pourretia, Cottenorfia, &c.

Order 27. Hypoxidaceæ, the Hypoxis Family. Perianth petaloid, superior; usually six-parted, regular; stamens six, inserted into the base of the segments of the perianth; filaments distinct; anthers introrse. Ovary inferior; three-celled; ovules numerous, amphitropal; style simple; stigma three-lobed. Fruit indehiscent, sometimes succulent, one-, two-, three-celled. Seeds 00, with a lateral hilum and a beaked caruncle; testa black and crustaceous; embryo straight, in the axis of fleshy albumen; radicle remote from the hilum. Herbaceous and usually stemless plants, with

tuberous and fibrous roots, radical plaited leaves, and simple or branched scapes. Natives of warm countries. Some have bitter roots, others have edible tubers. There are four known genera, including sixty species. Examples: Hypoxis, Curculigo.

The common American Hypoxis erecta belongs to this order, which is not retained by Dr. Gray.

ORDER 28. AMARYLLIDACEÆ, the Amaryllis Family. Perianth petaloid, regular, six-cleft, the outer segment overlapping the inner. Stamens six, inserted in the perianth, sometimes cohering by the dilated bases, and forming a kind of cup; occasionally there are additional sterile stamens, which sometimes form a corona above the tube of the perianth; anthers introrse. Ovary inferior, three-celled; ovules 00, anatropal; style one; stigma three-lobed. Fruit either a three-celled, three-valved capsule, with loculicidal dehiscence, or baccate. Seed with a thin or thick, or black and brittle spermoderm; albumen fleshy; embryo nearly straight; radicle next to hilum. Usually bulbous plants, sometimes with fibrous roots; leaves ensiform, with parallel veins; flowers spathaceous; stem sometimes woody and tall. Natives chiefly of the Cape of Good Hope. But species are found in Europe, East and West Indies, America, and Australia.

Tribe 1. *Agaveæ*, with fibrous roots, both segments of the perianth alike. Examples: Fourcroya, Agave, Doryanthes, Bravoa, &c. The most remarkable species of Agaveæ, is Agave americana (hundred year aloe, century plant, &c). The trivial name is derived from the old idea that inflorescence took place but once in a century. This species found wild in warmer America, furnishes the pulque of the Mexicans. A small species, A. virginica, is found in the Southern States.

Agave americana (*pl.* 57, *fig.* 8, *a–d*). *Fig.* 8, *e*, represents the fruit of A. lurida.

Tribe 2. *Alstrœmerieæ.* Fibrous roots, outer segment of the perianth different in form from the inner. Example: Alstrœmeria.

Tribe 3. *Narcisseæ.* Bulbous: flowers with a corona. Ex. Narcissus. The daffodil, a prominent species of Narcissus (N. pseudo-narcissus), is represented in *pl.* 58, 59, *fig.* 2, *a–c*. Other species are N. poeticus, the narcissus: N. jonquilla, the jonquil; &c.

Tribe 4. *Amarylleæ.* Bulbous: flowers without a corona. Ex. Amaryllis. A. atamasca is a North American species; A. formosissima, a South American (*pl.* 58, 59, *fig.* 1.)

ORDER 29. HÆMODORACEÆ, the Bloodwort Family. Herbs with fibrous roots, usually equitant leaves, and perfect three- or six-androus regular flowers, which are woolly or scurfy outside, the tube of the six-lobed perianth coherent with the whole surface, or with merely the lower part of the three-celled ovary. Anthers introrse: style single, sometimes three-partible. Pod crowned, or inclosed by the persistent perianth: three-celled, loculicidal three- to many-seeded. Embryo small, in hard or fleshy albumen. Examples: Hæmodorum, Lachnanthes, Lophiola, Aletris, &c.

ORDER 30. BURMANNIACEÆ, the Burmannia Family. Perianth colored, tubular, six-cleft, the three outer segments (calyx) often keeled at the back,

the three inner (petals) minute. Stamens three, inserted in the tube of the perianth, opposite its inner segments, sometimes with three alternating sterile filaments; anthers dithecal, opening transversely, with a fleshy connective. Ovary inferior, either one- or three-celled, in the latter case the cells opposite the outer segments of the perianth; ovules, 00; style, simple; stigmas, three. Fruit, a one- or three-celled, three-valved capsule, crowned by the persistent perianth. Seeds 00, minute, striated Herbs, with radical leaves and bisexual flowers. Natives of most grassy places in tropical regions. They have no properties of importance. There are about ten known genera and thirty-five species. Examples: Burmannia, Apteria, Apostasia.

Order 31. Iridaceæ, the Iris Family. Perianth adherent, six-parted, colored, in two, often unequal whorls. Stamens three, epigynous, opposite the outer segments of the perianth; filaments distinct or monadelphous; anthers two-celled, extrorse. Ovary inferior, three-celled; ovules numerous, anatropal; style one; stigmas three, often petaloid, sometimes bilabiate. Fruit, a three-celled, three-valved capsule, with loculicidal dehiscence. Seeds numerous; embryo inclosed in horny or fleshy albumen; radicle next the hilum. Herbs, rarely undershrubs, with rhizomes or underground corms, having their leaves often equitant or distichous, and their flowers spathaceous. Natives chiefly of warm and temperate regions. They abound at the Cape of Good Hope. There are fifty-three known genera, and five hundred and fifty species. Examples: Iris, Sisyrinchium. Witsenia, Gladiolus, Ixia, Crocus.

Certain plants of this order have an economical value. Orris-root is obtained from Iris florentina. The roasted seeds of I. pseudacorus have been used as a substitute for coffee. Saffron consists of the stigmata of Crocus sativus, a species originally from Asia Minor, now extensively spread. Numerous species of Iris occur in North America: Sisyrinchium or Blue-eyed grass also belongs here.

Pl. 58, 59, *fig.* 4, *a–i*, Iris germanica, an European species. *Pl.* 58, *fig.* 3, Crocus sativus.

Order 32. Musaceæ, the Banana Family. Perianth six-cleft, adherent, petaloid, in two whorls, more or less irregular. Stamens six, inserted on the middle of the segments of the perianth, some usually abortive; anthers linear, dithecal, introrse, often with a membranous petaloid crest. Ovary inferior, three-celled; ovules numerous, anatropal; style simple; stigma usually three-lobed. Fruit, either a three-celled capsule, with loculicidal dehiscence, or succulent and indehiscent. Seeds sometimes surrounded by hairs; testa usually crustaceous; embryo erect in the axis of mealy albumen; radicle touching the hilum. Plants without true aerial stems, or nearly so, having shoots proceeding from subterranean root-stocks, which form spurious stems, composed of the sheathing leaf-stocks. Veins in the limb of the leaf parallel, and proceeding in a curved manner from the midrib to the margin. Flowers bursting through spathas. Natives of warm and tropical regions: there are five known genera and twenty-one species. Examples: Musa, Strelitzia, Ravenala, Heliconia.

Plants of this order are highly important. The Banana fruit, which constitutes the chief food of certain inhabitants of tropical climates, is obtained from Musa sapientum and M. cavendishii. M. paradisaica furnishes the plantain; M. textilis yields a fine textile fibre.

Pl. 58, 59, *fig.* 5, Musa paradisaica; *a–e*, various parts of the plant; *f*, cross-section of the ovary; *g*, ripe fruit; *h*, cross-section of ditto.

ORDER 33. MARANTACEÆ, the Arrow-root Family. Perianth superior, in two whorls; outer (calyx) three-lobed, short; inner (corolla) tubular, elongated, three-parted, segments nearly equal. Stamens in two whorls; outer sterile, petaloid, irregular, resembling a tubular trifid corolla, with one of the lateral segments different from the others; inner petaloid, two sterile, and one lateral fertile; filament of the latter petaloid, entire or two-lobed; anther on the margin of the filament, one-celled, dehiscing longitudinally. Ovary three-celled, rarely one-celled; ovules solitary and erect, or numerous and attached to the axis, style petaloid or swollen; stigma either the naked apex of the style, or hollow, hooded, and incurved. Fruit a three-celled capsule, or baccate, one-celled and one-seeded. Seeds round, without arillus; embryo straight, in hard, somewhat floury albumen, without a vitellus; radicle lying against the hilum. Herbaceous plants, with tuberous rhizomes, and leaves and flowers similar to those of the Ginger family. They are natives of tropical regions. There are six genera, including 160 species. Examples: Maranta, Canna, Phrynium.

The West Indian arrow-root is obtained from the tuberous roots of Maranta arundinacea. The seeds of Canna indica are known as Indian shot.

ORDER 34. ZINGIBERACEÆ or SCITAMINEÆ, the Ginger Family. Perianth superior, in two whorls; outer (calyx) tubular, three-lobed, short; inner (corolla) tubular, elongated, three-parted, segments nearly equal. Stamens in two whorls; outer sterile, petaloid, having the appearance of a three-parted coralline whorl, with the intermediate segment (labellum) larger than the rest, and often three-lobed, sometimes the lateral segments are inconspicuous or nearly abortive; inner stamens three, the two lateral being abortive, the intermediate one opposite the labellum, fertile; filament not petaloid, often prolonged beyond the anther; anther two-celled, dehiscing longitudinally. Ovary three-celled, or imperfectly so; ovules several, anatropal, attached to a placenta in the axis: style filiform; stigma dilated, hollow. Fruit usually a three-celled capsule, sometimes baccate. Seeds roundish or angular, sometimes with an arillus; embryo inclosed in a vitellus (the remains of the embryo-sac), surrounded by farinaceous albumen, which is deficient near the hilum. Herbs, with a creeping rhizome, and simple sheathing leaves, having parallel veins proceeding from the midrib to the margin. The flowers arise from membranous spathaceous bracts. Natives of tropical countries. Twenty-nine genera and 247 species. Examples: Zingiber, Curcuma, Amomum, Hedychium, Renealmia.

The ginger of commerce is derived from the rhizomes of Zingiber officinale growing in the East and West Indies. Preserved ginger consists of the younger rhizomata. Curcuma longa and zedoaria furnish turmeric, a

well-known yellow die. Cardamom seeds come from various species of Amomum and Elettaria.

Zingiber officinale (*pl.* 58, 59, *fig.* 7); *a*, the entire plant; *b*, *c*, pieces of the rhizoma. 1–6, various parts of the flower; 7–11, do. of the fruit. Curcuma zedoaria (*pl.* 58, *fig.* 6),) 1–5, rhizoma; *a–e*, various parts of the plant.

Order 35. Orchidaceæ, the Orchis Family. Flowers bisexual. Perianth adherent, herbaceous, or colored, with a six-partite limb, the segments being arranged in two rows; exterior row, called the calyx (although Lindley says it is more properly the corolla, the true calyx or calyculus being usually abortive), consisting of three segments (rarely two by adhesion), the odd one of which is often next the axis by a twisting of the ovary; interior row called the corolla (regarded by Lindley as petaloid stamens), consisting usually of three segments (very rarely one), the odd one of which is called the labellum or lip. This labellum frequently differs from the other divisions of the perianth, assuming remarkable forms, being lobed, spurred at the base, or furnished with peculiar appendages, which are sometimes derived from the stigma. It is sometimes divided by contraction, so as to exhibit three distinct portions, the lowest being the hypochilium; the middle, mesochilium; and the upper, the epichilium. Stamens three, epigynous, united in a central column along with the style; the two lateral stamens are usually abortive, the central one opposite the odd exterior segment being fertile; but at times the two lateral are fertile, and the central one is abortive; anthers one-, two-, four-celled; pollen powdery or cohering in definite or indefinite waxy masses (pollinia), which often adhere by a caudicle to a gland connected with the beak (rostellum) of the stigma. This gland is sometimes naked, at other times in a sac or pouch (bursicula). Ovary adherent, one-celled, composed of six carpels, of which three only are placentiferous (Lindley); style incorporated with the column (gynostemium, pistil, and stamen); stigmas a viscid hollow space in front of the column, communicating directly with the ovary by an open canal. The upper part of the united stigmas is often extended into a beak-like process (rostellum). Placentas three, parietal. Fruit a capsule, opening by three or six valves, rarely fleshy, and indehiscent. Seeds 00, very minute, with a loose reticulated spermoderm, exalbuminous; embryo solid, fleshy; large radicle next the hilum. Perennial herbs or shrubs, with fibrous or tubercular roots, either no stem or a pseudo-bulb, entire parallel-veined often sheathing leaves, and generally showy, attractive flowers. Sometimes buds are produced on the margins of the leaves. They are natives of almost all parts of the world, but they abound in moist tropical regions. They are not found in the Arctic regions, nor in very dry climates. Some are terrestrial, and others are epiphytic. The former are commonly seen in temperate climates, the latter in warm regions.

The plants of this order are well distinguished by the peculiar form of their flowers, their remarkable lip, gynandrous stamens, and pollen masses. Their flowers often resemble insects, as butterflies, moths, bees, flies, and spiders; or birds, as doves and eagles; or reptiles, as snakes, lizards, and

frogs. The colors and spots on the perianth sometimes give the appearance of the skins of quadrupeds, as the leopard and tiger. These resemblances are often indicated in the generic and specific names. The labellum, in some instances, displays peculiar irritability.

Tribe 1. *Cypripedieæ.* Pollen pulpy granular. Fertile anthers two, with a dilated petal-like body (the third stamen) between them. Example: Cypripedium, or Ladies' slipper, of which various American species exist.

Tribe 2. *Neottieæ.* Pollen powdery, in numerous minute and angled loosely cohering grains (forming two or four masses). Anther more or less parallel, with the stigma or column erect. This tribe includes the following sub-tribes: *Cranichideæ*, *Listerideæ*, *Spiranthideæ*, *Physurideæ*, *Diurideæ*, and *Thelymitrideæ.* Examples: Cranichis, Acroca; Listera, Neottia; Speranthes; Goodyera; Diuris; Epiblema.

Tribe 3. *Arethuseæ.* Pollen, as in the last. Anther terminal, forming a lid over the stigma. Sepals and petals mostly erect or converging. Sub-tribes: *Limnodorideæ*, *Acianthideæ*, *Caleyideæ*, *Pogonideæ*, *Gastrodideæ*, and *Vanillideæ.* Examples: Chlorea, Microtis; Acianthus, Corybas; Caleya; Pogonia, Arethusa, Calopogon; Gastrodia; Vanilla. The fleshy pods of Vanilla planifolia and V. claviculata furnish the vanilla of the confectioner.

Tribe 4. *Ophrydeæ.* Pollen cohering in very numerous grains, which are collected on a cobweb-like tissue into two large masses, and affixed to the glands of the stigma. Flower ringent: lips with a spur at the base beneath. Sub-tribes: *Serapiadeæ*, *Satyriadeæ*, *Gymnadenideæ*, *Holothrichideæ*, *Disideæ*, *Corycideæ.* Examples: Orchis, Ophrys, Pachites, Gymnadenia, Plathanthera, Holothrix; Disa, Forficaria; Corycium, Arnottia.

Tribe 5. *Vandeæ.* Pollen cohering in definite (two or four) waxy masses, furnished with an elastic prolongation (caudicle). Sub-tribes: *Sarcanthideæ*, *Cryptochilideæ*, *Brassideæ*, *Pachyphyllideæ*, *Maxillarideæ*, *Catasetideæ*, *Notylideæ*, *Ionopsideæ*, and *Calanthideæ.*

Tribe 6. *Epidendreæ.* Pollen coherent, in definite waxy masses, furnished with a caudicle: anther terminal, opercular. Epiphytic or terrestrial plants. Sub-tribes: *Cœlogynideæ*, *Isochilideæ*, *Lœliadeæ*, and *Bletideæ.*

Tribe 7. *Malaxideæ.* Pollen cohering in definite (four) waxy masses, without any connecting tissue or caudicle. Sub-tribes: *Pleurothallideæ*, *Liparideæ*, *Dendrobideæ*, and *Corallorhizideæ.* Examples: Microstylis, Liparis, Corallorhiza, Aplectrum.

Pl. 58, 59, *fig.* 8, Vanilla aromatica, or Vanilla.

Order 35. Hydrocharidaceæ, the Frog-bit Family. Flowers spathaceous, unisexual, rarely ☿. Perianth with a six-partite limb; the three outer segments herbaceous and equivalent to the calyx, the three inner petaloid and equivalent to the corolla. Stamens definite or indefinite, epigynous. Ovary adherent, one- or many-celled; ovules 00, anatropal, frequently attached to parietal placentas; stigmas three to six. Fruit dry or succulent, indehiscent, uni- or pluri-locular. Seeds numerous, exalbuminous; embryo straight, radicle remote from the hilum. Floating or aquatic plants,

with parallel-veined leaves, sometimes spiny. Chiefly found in Europe, Asia, and North America. The plants of this order are not remarkable for their properties. Some are mucilaginous and astringent. Vallisneria spiralis is a diœcious plant, the male flowers of which, at the time of flowering, are said to be detached from the mud of the water in which they grow, and to float on the surface. At the same time the female flower developes a long, spiral peduncle, by means of which it reaches the surface of the water, so as to allow the application of the pollen. The canvas-back duck (Aythya vallisneria) derives its specific name from feeding on this plant, known in the Chesapeake Bay as the celery grass.

This order has been divided into two sections: *Stratioteæ*, with a many-celled ovary, and *Vallisnerieæ*, ovary one-celled. Examples: Limnobium, Udora, Vallisneria.

Sub-Class 3. *Dictyogenæ.*

Leaves reticulated, often articulated with the stem, branches having the usual structure of Endogens, rhizomes or underground stems having the woody matter disposed in a compact circle, or in wedges containing central cellular tissue, and often showing medullary processes.

Order 37. Trilliaceæ, the Trillium Family. Flowers usually bisexual. Perianth in six, sometimes eight divisions, colored or herbaceous. Stamens six, eight, or ten; filaments subulate; anthers linear, with a prolonged connective. Ovary free, three-, four-, or five-celled; styles as many, distinct; ovules 00, anatropal. Fruit succulent, three-, four-, or five-celled. Seeds 00; embryo minute, in fleshy albumen. Natives of the temperate parts of Europe, Asia, and America. Some of them are more or less acrid, others are narcotic. The rhizome of Trillium cernuum is used as an emetic. Paris quadrifolia, Herb Paris, is narcotic. There are about ten known genera, and upwards of sixty species. Examples: Trillium, Paris, Medeola.

Order 38. Smilaceæ, the Greenbrier Family. Flowers bisexual or polygamous. Perianth petaloid, six-parted. Stamens six, inserted into the base of the perianth, rarely hypogynous. Ovary free, three-celled; cells uni- or multi-ovulate; ovules orthotropal; styles usually three-cleft; stigmas three. Fruit globular and succulent. Seeds with fleshy, cartilaginous albumen; embryo very small; usually distant from the hilum. Herbs or undershrubs, often climbing, with netted-veined leaves. Natives of the temperate and tropical regions of Asia and America. There are four or five known genera, and upwards of 120 species. Examples: Smilax, Philesia.

The Sarsaparilla of commerce is derived from the roots of various species of Smilax, the best article being furnished by S. officinalis, a native of Columbia; a poor substitute is found in the S. pseudo-china of the United States. The so-called wild sarsaparilla of the United states belongs to the genus Aralia. The tangled thickets of Greenbriers, so common in this country, are constituted by various species of Smilax.

ORDER 39. DIOSCOREACEÆ, the Yam Tribe. Flowers unisexual. Perianth six-divided, adherent. ♂. Stamens six, inserted into the base of the perianth; anthers introrse, with longitudinal dehiscence. ♀. Ovary inferior, three-celled; ovules one to two, anatropal; style bifid; stigmas undivided. Fruit a compressed trilocular capsule; with two cells, sometimes abortive, occasionally fleshy and indehiscent. Seeds compressed, winged or wingless, in the succulent fruit ovate; embryo small, near the hilum, lying in a large cavity of cartilaginous albumen. Twining shrubs, with large epigeal or hypogeal tubers, alternate, sometimes opposite, reticulated leaves, and small, spiked, bracteated flowers. Natives chiefly of tropical countries; a few only found in temperate regions. There are six genera according to Lindley, and 110 species. Examples: Dioscorea, Tamus, Elephantopus.

The Yam, a tropical substitute for the potatoe, is the tuber of several species of Dioscorea.

Class 3. *Dicotyledones and Exogenæ*, Juss. and D.C. *Acramphibrya*, Endl.

This is the largest class in the vegetable kingdom. The plants included under it have a *cellular* and *vascular* system, the latter consisting partly of elastic spiral vessels. *The stem* is more or less conical, and exhibits wood and true bark. *The wood* is exogenous, i. e. increases by additions at the periphery, the hardest part being internal. It is arranged in concentric circles. Pith exists in the centre, and from it diverge medullary rays. *The bark* is separable, and increases by additions on the inside. *The epidermis* is furnished with stomata. *The leaves* are reticulated, usually articulated to the stem. *The flowers* are formed upon a quinary or quaternary type, and have stamens and pistils. *The ovules* are either inclosed in a pericarp, and fertilized by the application of the pollen to the stigma, or they are naked, and fertilized by the direct action of the pollen. *The embryo* has two or more opposite cotyledons, and is exorhizal in germination.

Sub-class 1. *Monochlamydeæ.*

Corolla wanting; a calyx or a simple perianth present; flowers sometimes achlamydeous. This sub-class includes the Apetalous orders of Jussieu, and many of his Diclinous irregular orders. It corresponds to the Apetalæ and Gymnospermæ of Endlicher.

Section A. Gymnospermæ.

Monochlamydeous or Achlamydeous plants, with an exogenous structure as regards their stems and organs of vegetation, but differing from Exogens, in having naked ovules, which are fertilized by the direct application of the pollen to the foramen, without the intervention of stigma, style, and

ovary. Their woody tissue is marked by the presence of disks. They are included in Lindley's class of Gymnogens, and Endlicher's Gymnospermous division of Acramphibrya.

ORDER 40. CYCADACEÆ, the Cycas Family. Flowers unisexual. Males collected into cones, the scales bearing on their lower surface one-celled anthers, which are united often in sets of two, three, or four. Females consisting of naked ovules, placed at the base of flat scales, or beneath peltate ones, or seated on the margins of altered leaves. Seeds hard and nut-like, sometimes with an external spongy coat; embryo one or two, suspended in a central cavity; albumen fleshy or mealy; cotyledons unequal; radicle superior, having a long cord-like prolongation by which the embryo is suspended. Trees or shrubs, with cylindrical trunks, usually simple, sometimes dichotomous, marked with the scars of the leaves, and in many respects having the aspect of palms. The internal structure is more or less distinctly that of dicotyledons. Pitted tissue and spiral vessels occur. The leaves are pinnate, and their vernation is circinate, thus resembling ferns. The plants of this order are found in the temperate and warm regions of America and Asia, as well as at the Cape of Good Hope. There are six genera, according to Lindley, and forty-five species. Examples: Cycas, Zamia, Encephalartos, Macrozamia, Dion.

Some species of this order furnish an impure sago from the stem; the fruit of others is eaten, roasted like chestnuts. The family is interesting, from having fossil representatives. Cycas circinalis (*pl.* 56, *fig.* 4); Zamia elliptica (*fig.* 8).

ORDER 41. CONIFERÆ, the Pine Family. It includes the orders Pinaceæ, Taxaceæ, and Gnetaceæ of Lindley. Flowers unisexual. Male flowers monandrous or monadelphous; stamens collected in a deciduous amentum, about a common rachis; anthers one-, two-, or many-lobed, with longitudinal dehiscence, often terminated by a scaly crest. Female flowers in cones, sometimes solitary; ovary none, its place being supplied by the flat scales of the cones, arising from the axil of membranous bracts; ovules naked, usually in pairs on the face of the scales, inverted or erect; style 0; stigma 0. Fruit a cone, or a solitary naked seed. Seed with a hard crustaceous integument, sometimes winged, embryo in the midst of fleshy oily albumen; sometimes more than one embryo; cotyledons two, or many and verticillate; radicle next the apex of the seed, organically connected with the albumen. Trees or shrubs, with branched, usually resinous trunks, the wood marked with circular disks, the leaves usually narrow, rigid or accrose, entire, sometimes fascicled, and with a scaly sheath at their base. They are found in various parts of the world, both in cold and hot regions. They abound in the temperate regions of Europe and America, and many occur in Australia. Four genera of Coniferæ, Araucaria, Phyllocladus, Microcachrys, and Arthrotaxis, are peculiar to the southern hemisphere. The following attain their maximum to the south of the tropics: Callitris, Podocarpus, and Dacrydium. Dammara has one species in each hemisphere.

Sub-order 1. *Gnetaceæ*, the Joint-fir Tribe; male flowers with a perianth; anthers uni-, or quadrilocular, opening by a short cleft; ovules with a

projecting process formed from the intimate covering of the nucleus; seed solitary; embryo with a long spirally-twisted funiculus; stems jointed; zones of wood, often separated by marked cellular circles. Examples: Gnetum, Ephedra.

Sub-order 2. *Taxineæ*, the Yew Tribe; anthers usually bilocular, with longitudinal dehiscence; fertile flowers, solitary, terminal; ovule solitary, sessile in the centre of a fleshy disk, when in fruit forming a sort of drupe; embryo dicotyledonous. Examples: Taxus, Torreya, Cephalotaxus, Podocarpus, Dacrydium, Phyllocladus, Gingko. North American representatives: Torreya and Taxus (Taxus canadensis).

Sub-order 3. *Cupressineæ*, the Cypress Tribe. Ovules erect; fruit an indurated cone or fleshy, with the scales connected forming a galbulus; embryo di-, or poly-cotyledonous. Examples: Thuya, Taxodium, Juniperus, Cupressus, Cryptomeria, Thuyopsis, Callitris, Widdringtonia. North American genera are: Thuya (T. occidentalis or arbor vitæ), Cupressus (C. thyoides, white cedar), Taxodium (T. distichum, bald cypress), and Juniperus (J. communis, Juniper, and J. virginiana, Red cedar).

Sub-order 4. *Abietineæ*, the true Pines. Fertile flowers, in cones with one or two inverted ovules at the base of each scale; embryo in the axis of fleshy or oily albumen, di-, or poly-cotyledonous.

Div. 1. *Dammarieæ.* Scales one or many-seeded. Seeds free; anthers bi-, tri-, or multilocular. Examples: Dammara, Cunninghamia, Arthrotaxis, none North American.

Div. 2. *Araucarieæ.* Scales one-seeded, seed adnate to the scale, and not separating from it; anthers multilocular. Examples: Araucaria, Eutassa, Altingia. None North American.

Div. 3. *Abieteæ.* Scales two-seeded, seeds adnate to the scale and at length separating from it; anthers bilocular. There are three prominent subdivisions: *a.* Scales without an apophysis, leaves fasciculated. Examples: Larix (leaves flat, annual); Cedrus (leaves tetragonal, perennial). *b.* Scales without an apophysis, leaves solitary. Examples: Tsuga (scales persistent, leaves flat); Picea (scales persistent, leaves tetragonal); Abies (scales deciduous, leaves flat). *c.* Scales with a thickened apophysis, which is either entire or dimidiate. Examples: Pinus (leaves in twos, threes, fours, or fives). North American representatives: Larix (L. americana, Tamarack), Abies (A. balsamea, balsam fir; A. canadensis, Hemlock spruce; A. alba, White spruce; A. nigra, Black or Double spruce, &c.); Pinus (P. strobus, white pine; P. mitis, yellow pine; P. rigida, Pitch pine, &c).

The Coniferæ form an extensive element in the forest features of many portions of the globe. Nevertheless, the different genera are rather restricted in their distribution. Thus Abies, Larix, Pinus, Taxus, Torreya, and Cupressus, are entirely confined to the northern hemisphere, few indeed being found in tropical latitudes, except at considerable elevations. Juniperus and Thuya are quite generally distributed. Cryptomeria and Thuyopsis are natives of Japan; Callitris, with a single exception, of Australia; Widdringtonia is South African, and Taxodium, North

American. Araucaria is confined to South America, Eutassa and Arthrotaxis to Australia, Cunninghamia to China, Dammara to New Zealand and the adjacent islands, Sciadopitys to Japan. Of the Taxineæ, Taxus and Torreya have already been assigned to the northern hemisphere, where they are found on both continents. Cephalotaxus and Gingko belong to the eastern extremity of Asia, Phyllocladus to Australia, Dacrydium to the islands of Asia, and Podocarpus to various parts of the globe.

The economical value of the Coniferæ is very great. Many species furnish timber of the first quality, as also turpentine, rosin, tar, pitch, &c. Canada Balsam is the exuded and inspissated juice of Abies balsamea and fraseri, known as Balsam firs. Callitris quadrivalvis supplies Sandarach or pounce; Abies excelsa or Norway spruce, the Burgundy pitch or Frankincense. The oil from the berries of Juniper gives the peculiar flavor to Holland gin. The wood of lead pencils is derived from Juniperus bermudianus. The Gopher wood of Scripture is probably the cypress of modern times (Cupressus sempervirens). Many trees of this order furnish timber of extraordinary durability. The seeds of various species form a pleasant article of food.

Taxus baccata or common European Yew (*pl.* 72, *fig.* 10); *a*, a branch with male flowers; *b*, male catkin with the anterior part of the scales removed; *c*, connective covering the anther cells; *e*, a branch with female flowers; *f*, one-flowered male catkin; *g*, the same two-flowered; *h*, a female flower; *i*, a section of the same; *k*, single flowered female catkin; *l*, the flower separate; *m*, branch with fruit; *n* and *o*, fruit.

Juniperus communis, common Juniper (European) (*pl.* 72, *fig.* 11); *a*, branch with fruit; *b*, portion of a branch with male flowers; *c*, do. with female flowers; *d*, male catkin, *e*, anther cells with their covering: *f*, the three female flowers; *g*, transverse section of the carpophores; *h*, two flowers with their carpophores, the one in vertical section; *i*, section of the berry; *k*, a seed; *l*, vertical section of do. Pinus picea; the stone Pine (European) (*pl.* 72, *fig.* 14); *a*, branch with male catkins; *b*, a strobile; *c*, carpellary scale with its two seeds.

Larix cedrus, European cedar (*pl.* 72, *fig.* 13); *a*, branch with a male catkin; *b*, the two anther cells; *c*, extremity of a branch with a female catkin; *d*, scale with the two female flowers; *e*, carpellary scale with the two seeds; *f*, vertical section of the seed.

Cupressus sempervirens, European cypress (*pl.* 72, *fig.* 12); *a*, branch with male and female catkin; *b*, male catkins; *c*, bracts with the anther filaments; *d*, female catkins; *e* and *f*, female flowers; *g–l*, various stages of fruit and seeds.

Section B. Angiospermæ.

Monochlamydeous or achlamydeous plants having their seeds contained in an ovary and fertilized by the action of the pollen on a stigma. It corresponds to the Apetalous division of Endlicher's Acramphibrya.

ORDER 42. GARRYACEÆ, the Garrya Family. Flowers unisexual, amentaceous. Male flowers, perianth of four parts, stamens four, alternate with the segments of the perianth. Female flowers, perianth superior, two-toothed; ovary unilocular; ovules two; pendulous on short funiculi; styles two. Fruit baccate, indehiscent. Seeds two; embryo minute, at the base of fleshy albumen. North American shrubs, with opposite, exstipulate leaves. The male plants of *Garrya elliptica* are commonly cultivated in shrubberies, and are prized for their peculiar silky catkins. Lindley associates with this order the Helwingiaceæ, which agree in their unisexual flowers, adherent fruit, pendulous ovules, minute embryo, at the base of the solid albumen. There are two known genera, and six species. Example: Garrya.

ORDER 43. JUGLANDACEÆ, the Walnut Family. Flowers unisexual. Male flowers amentaceous: perianth membranous, oblique; irregularly-lobed, with a scaly bract. Stamens definite or 00: filaments short, free; anthers dithecal, erect. Female flowers in terminal clusters, or in loose racemes, with separate or united bracts: perianth, single or double, the outer three- or five-parted, inner, when present, in minute separate pieces. Ovary adherent to the perianth, one-celled; ovule solitary, erect, orthotropal; styles one or two, very short; stigmas two or four, fringed or sessile discoid, and four-lobed. Fruit a drupe, sometimes with an adherent involucre; endocarp bony, two-valved, or valveless, two- or four-celled at the base, and one-celled at the apex, with partial dissepiments. Seed exalbuminous, two- or four-lobed, with a membranaceous testa; embryo large; cotyledons fleshy, oily, and sinuous; radicle superior. Trees with alternate, pinnated leaves, having neither dots nor stipules. Examples: Juglans, Carya, Engelhardtia, and Pterocarya.

The plants of this family are chiefly North American, where they are represented by one genus (Carya) peculiar to the country, and another (Juglans) which possesses one European species. The fruit of Carya, known as hickory nuts, shell barks, Pecan nuts, &c., is highly prized as an article of food, while the timber is of exceedingly great value. The Walnut and Butternut, or white Walnut, belong to the genus Juglans; the wood of the former species is hardly surpassed as a beautiful material for cabinet ware. The bark of Juglans cinerea, or butternut, is a valuable medicinal agent.

Juglans regia, English walnut (European) (*pl.* 71, *fig.* 4); *a*, branch with male catkins and female flowers; *b*, male flowers on a scale; *c*, a male flower enlarged; *d*, female flower; *e*, vertical section of ditto; *f*, fruit with part of the hull removed; *g*, longitudinal section.

ORDER 44. AMENTACEÆ, the Catkin Family. Flowers unisexual. Male flowers capitate or in catkins (amenta), sometimes with a membranous perianth. Female flowers, clustered, solitary, or in catkins. Stamens varying from one to twenty, distinct or monadelphous; anthers dithecal. Ovary usually simple; stigmas one or more. Fruit membranous, or bony, or drupaceous, indehiscent or dehiscent. Seeds solitary or numerous, erect or pendulous, usually exalbuminous; embryo straight or curved; radicle mostly

superior. Trees or shrubs with alternate, stipulate, or exstipulate leaves. Natives chiefly of temperate climates. The order has been divided into the following sub-orders:

Sub-order 1. *Cupuliferæ*, the Oak Family. Trees or shrubs with alternate and simple straight-veined leaves, deciduous stipules, and monœcious flowers; the sterile in catkins (aments or capitate clustered in the Beech), the fertile solitary or clustered, furnished with an involucre which forms a cup or covering to the one-celled, one-seeded nut. Ovary, two- or seven-celled, with one or two pendulous anatropous ovules in each cell, but all the cells and ovules, except one, disappearing in the fruit. Calyx adherent to the ovary, the minute teeth crowning its summit. Seed with no albumen, filled with the embryo; cotyledons very thick and fleshy; radicle short, superior. Examples: Quercus, Castanea, Fagus, Corylus, Carpinus, Ostrya, Lithocarpus. All of these, with the exception of the last, have North American species. In oaks (Quercus) North America is especially rich, the northern and middle States alone possessing twenty species, not to mention numerous others peculiar to the south and west of the continent. Some of the southern species, as the Live Oak (Q. virens), have evergreen leaves. Of Castanea there are three species in the United States: the common Chestnut (C. vesca), the Chincapin (C. pumila), and a still smaller species, C. nana. The common American Beech is Fagus ferrugineus. There are also the Hazelnut (Corylus americana and rostrata), the Hornbeam (Carpinus americana), and the Ironwood (Ostrya virginica).

Sub-order 2. *Plataneæ*, the Plane Tribe. Flowers in globose catkins; stamen one, with scales; ovary, one-celled; style, thick and subulate; ovules, solitary or in pairs; suspended, orthotropal: fruit consisting of compressed clavate nuts, terminated by a recurved style: seeds one or two, pendulous, albuminous: radicle, inferior; leaves palmate or toothed, and stipulate. Natives chiefly of temperate regions. The principal genus in this family is Platanus, represented in the Old World by P. orientalis, the Plane tree, and in the New by P. occidentalis, Button-wood, or Sycamore.

Sub-order 3. *Balsamifluæ*, the Sweet-Gum Tribe. Flowers with verticillate bracts or minute scales; anthers, numerous; ovary, two-celled; ovules 00, amphitropal: fruit consisting of two-celled capsules, united together, so as to form a hard cone: seeds usually numerous, winged, albuminous; radicle superior; leaves stipulate. Balsamic trees natives of tropical and warm regions. The characteristic genus of this family is Liquidambar, embracing three species, two Asiatic and one North American. The latter, L. styraciflua, or sweet-gum, is abundant in the south-eastern portion of the continent.

Sub-order 4. *Betulineæ*, the Birch Tribe. Flowers with bracts which are sometimes verticillate: ovary, two-celled; ovules solitary, pendulous, anatropal: fruit membranous, indehiscent, forming a sort of cone; seeds pendulous, radicle superior, leaves with deciduous stipules. Natives of temperate and cold regions in Europe, Asia, and America, and extending to arctic and antarctic regions. Examples: Betula and Alnus. Of Betula, or birch, there are numerous species in North America; the most important

of them is B. papyracea, paper or canoe birch, from whose bark the northern and western Indians and hunters manufacture their canoes. The genus Alnus, or Alder, is of little economical importance.

Sub-order 5. *Casuarineæ*, the Beefwood Tribe. Flowers with bracts; stamen one; ovary one-celled; ovules one to two; fruit consisting of winged achænia, collected into a cone; seed erect; radicle superior. Australian trees or shrubs, with filiform branches, bearing membranous toothed sheaths in place of leaves.

Sub-order 6. *Myriceæ*, the Myrtle Tribe. Achlamydeous flowers; stamens two to eight in the axil of a scale; ovary one-celled, with hypogynous scales; ovule solitary, erect, orthotropal; fruit drupaceous, often with a waxy secretion, and with fleshy adherent scales; radicle superior. Natives both of temperate and tropical regions, and found in North and South America, in India, and at the Cape of Good Hope. North American genera, Myrica and Comptonia. Examples: Myrica gale, Sweet gale or Bog-myrtle; M. cerifera, wax myrtle; and Comptonia asplenifolia or sweet fern.

Sub-order 7. *Salicineæ*, the Willow Tribe. Diœcious trees or shrubs, with both kinds of flowers in catkins, one under each bract, entirely destitute of calyx or corolla; the fruit a one-celled and two-valved pod, containing numerous seeds clothed with a long silky down. Ovary one-celled or imperfectly two-celled; styles two, very short, or more or less united, each with a two-lobed stigma. Seeds ascending, anatropous, without albumen. Cotyledons flattened; leaves alternate, undivided, with scale-like and deciduous, or leaf-like and persistent stipules. Wood soft and light, bark bitter. The genera Salix and Populus, known respectively as Willows and Poplars, have numerous North American species, although none of sufficient importance to require special mention. They are of little value as timber trees, owing to the soft and spongy texture of their wood; the charcoal, however, is in much request by gunpowder manufacturers.

Quercus tinctoria, Black oak, is a North American tree from which the yellow dye, Quercitron, is obtained. See *pl.* 72, *fig.* 8; *a*, branch with fruit; *b*, a leaf; *c*, represents a female flower of the Cork oak (Q. suber).

Chastena vesca or Chestnut (European variety). *Pl.* 72, *fig.* 7; *a*, branch with male and female flowers; *b*, a nut; *c*, the same in the partly removed hull.

Liquidambar styraciflua, Sweet Gum (North American). *Pl.* 72, *fig.* 9; *a*, branch with leaves and flowers; *b*, anther; *c*, pistil; *d*, the fruit; *e*, open pod; *f*, ovary; *g*, dissepiment with the seeds; *h*, a single seed.

Order 45. Piperaceæ, the Pepper Family. Flowers ☿. Perianth 0, flowers supported on a bract. Stamens two, three, or six, arranged on one side or all around the ovary; anthers one- or two-celled, with or without a fleshy connective; pollen roundish, smooth. Ovary solitary, free, one-celled; ovule solitary, erect, orthotropal; stigma simple, sessile, rather oblique. Fruit somewhat fleshy, indehiscent, unilocular. Seed erect; embryo in a fleshy vitellus outside the albumen, and at the apex of the seed. Shrubs or herbs, with articulated stems, opposite (sometimes alternate by abortion of one of the pair of leaves), or verticillate, exstipulate or stipulate

leaves, and spiked or racemose flowers. Natives of the hottest quarters of the globe. Common in South America and India. The wood is often arranged in wedges, with medullary rays, but without concentric zones. There are twenty-one known genera, and upwards of six hundred species. Examples: Piper, Artanthe, Peperomia.

The plants of this order have pungent, acrid, and aromatic properties. Most of them contain an acrid resin, and a peculiar principle called piperine. Black pepper is the dried unripe fruit of Piper nigrum, and white pepper the ripe fruit deprived of its outer covering. Cubeba officinalis, a Javan plant, furnishes Cubeb pepper. The Kava of the South Sea Islands is the root of Piper methysticum, and is employed in preparing an intoxicating beverage. The Betel leaf from Piper betle, is chewed in the East with the Areca nut.

Piper nigrum, Black pepper (East Indies) (*pl.* 72, *fig.* 6); *a*, a branch with flowers and fruit; *b*, portion of a catkin magnified; *c*, portion of the same dried and magnified; *d*, berry; *e–f*, section of the fruit; *g*, embryo; *h*, anther; *l*, unripe berry dried and constituting black pepper; *k*, white pepper.

Order 46. Saururaceæ, the Lizard's-tail Family. Flowers bisexual. Perianth 0, a scale or bract supporting the flowers. Stamens three to six, clavate, hypogynous, persistent; filaments slender; anthers two-celled, continuous with the filament, with a thick connective separating the lobes, dehiscence longitudinal. Ovaries three to four, distinct, with one ascending orthotropal ovule, and a sessile recurved stigma, or united so as to form a three- to four-celled pistil, with several ovules and three to four stigmas. Fruit either consisting of four fleshy indehiscent nuts, or a one-, three-, or four-celled capsule, dehiscing at the apex, and containing a few ascending seeds. Seeds with a membranous spermoderm; embryo minute, lying in a fleshy vitellus, outside of hard mealy albumen, at the apex of the seed. Herbs growing in marshy places, with alternate stipulate leaves, and spiked flowers. Natives of North America, India, and China. Their properties are said to be acrid. There are four known genera, according to Lindley, and seven species. Examples: Saururus, Houttuynia. The species Saururus cernuus or Lizard's-tail, represents the family in the United States.

Order 47. Chloranthaceæ, the Chloranthus Family. Flowers bisexual or unisexual, with a supporting scale. Perianth 0, stamens definite, lateral, and if more than one, connate; anthers monothecal, with longitudinal dehiscence, each adnate to a fleshy connective. Ovary unilocular; ovule solitary, pendulous, orthotropal; stigma sessile, simple. Fruit drupaceous, indehiscent. Seed pendulous; embryo minute, at the apex of fleshy albumen; cotyledons divaricate; radicle inferior, remote from the hilum. Herbs or undershrubs, with jointed stems, opposite, simple, stipulate leaves, sheathing petioles, and spiked flowers. Natives of the warm regions of India and America. Some of them, as Chloranthus officinalis, are aromatic and fragrant, and have been used as stimulants and tonics. Examples: Hedyosmium, Ascarina, Chloranthus.

ORDER 48. LACISTEMACEÆ, the Lacistema Family. Flowers polygamous. Perianth in several narrow divisions, covered by an enlarged bract. Stamens, one, hypogynous; anther having two cells, which are separated by a thick, two-lobed connective, and which dehisce transversely. Disk fleshy. Ovary superior, one-celled; ovules several, anatropal, attached to two or three parietal placentas; stigmas two or three, nearly sessile. Fruit a unilocular, two- or three-valved capsule, with loculicidal dehiscence. Seed usually by abortion, solitary, suspended, with a fleshy arillus; spermoderm crustaceous; embryo in fleshy albumen; cotyledons flat; radicle cylindrical, superior. Small trees or shrubs, with simple, alternate, exstipulate leaves, and amentaceous flowers. They are natives of the warm parts of America. Their properties are unknown. There are two genera and six species. Example: Lacistema.

ORDER 49. ATHEROSPERMACEÆ, the Plume-Nutmeg Family. Flowers unisexual. Perianth tubular, divided at the top into several segments, in two rows, the inner often petaloid, and accompanied in the female flowers with a few scales. Male flowers: stamens 00, inserted in the bottom of the perianth; filaments, with scales at the base; anthers two-celled, with valvular dehiscence. Female flowers: ovaries, usually 00; ovule solitary, erect; style simple, lateral, or basilar; stigmas, simple. In some flowers, though rarely, stamens and pistils are found, and in that case the stamens are fewer, and arise from the orifice of the perianth. Fruit consisting of achænia, with persistent, ultimately feathery styles, inclosed within the tube of the perianth. Seed solitary, erect; embryo small, at the base of soft, fleshy albumen; radicle inferior. Trees with opposite exstipulate leaves, found in Australia, and in some parts of South America. They are generally fragrant. There are three known genera and four species, according to Lindley. Examples: Atherosperma, Laurelia.

ORDER 50. MONIMIACEÆ, the Monimia Family. Flowers unisexual. Perianth somewhat globose, in one or more rows, divided at the border. Male flowers: stamens indefinite, covering the whole interior of the perianth; filaments, often with two scales at the base; anthers dithecal, with longitudinal dehiscence. Female flowers: ovaries several, superior, inclosed within the tube of the perianth, each with one style and one stigma; ovule solitary, pendulous, anatropal. Fruit consisting of several achænia, inclosed within the enlarged perianth. Seed pendulous: embryo, at the end of copious fleshy albumen; radicle superior. Trees or shrubs, with opposite, exstipulate leaves. They are natives chiefly of South America and Australia. The bark and leaves are aromatic and fragrant. The succulent fruit of some is eaten. There are eight known genera and about forty species. Examples: Monimia, Boldoa.

ORDER 51. STILAGINACEÆ, the Stilago Family. Flowers unisexual. Perianth two-, three-, or five-parted. Male flowers: stamens two or more, arising from a swollen receptacle; filaments, capillary; anthers innate, two-lobed, with a fleshy connective, and vertical cells opening transversely. Female flowers: ovary free, one- or two-celled; ovules two, anatropal; stigma sessile, three- to five-toothed. Fruit drupaceous. Seed solitary,

suspended; embryo, in fleshy albumen; cotyledons, leafy; radicle, superior. Trees or shrubs, with alternate, stipulate leaves. Natives chiefly of the East Indies. Some yield edible fruits, others are used as potherbs. The position of this order in the natural system is obscure. Lindley places it in the Urtical alliance, others consider it as allied to Amentaceæ. There are three known genera and about twenty species. Examples: Stilago, Antidesma.

ORDER 52. PODOSTEMACEÆ, the Podostemon Family. Flowers naked, or with a more or less perfect perianth, bursting through an irregularly lacerated spatha. Stamens hypogynous, definite or indefinite, distinct or monadelphous; anthers dithecal, with longitudinal dehiscence. Ovary free, two- or three-celled; ovules numerous, anatropal, attached to a fleshy central placenta; styles or stigmas, two or three. Fruit slightly pedicellate, capsular, two- or three-valved. Seeds 00; embryo exalbuminous, orthotropal. Herbaceous, branched, floating plants, with capillary, or linear, or lacerated, or minute and imbricated leaves. Natives chiefly of South America, and of the islands to the east of Africa. There are nine known genera and twenty-five species, according to Lindley. Examples: Podostemon, Lacis.

ORDER 53. CERATOPHYLLACEÆ, the Hornwort Family. Flowers unisexual. Perianth inferior, ten- or twelve-parted. Male flowers: stamens, twelve to twenty; anthers sessile, bilocular. Female flowers: ovary free, one-celled; ovule solitary, pendulous, orthotropal; style filiform, oblique; stigma simple. Fruit, a one-celled indehiscent nut, terminated by the hardened style. Seed solitary, pendulous, exalbuminous: cotyledons two, but apparently four; radicle inferior. Aquatic submersed herbs, with verticillate leaves cut into filiform lobes. They are found in ditches in various parts of Europe, Asia, and America. Of the single genus Ceratophyllum, North America possesses a single species.

ORDER 54. URTICACEÆ, the Nettle Family. Flowers unisexual, hermaphrodite, or polygamous, scattered or collected into catkins or heads. Perianth usually divided. Stamens definite, inserted into the perianth; filaments, sometimes curved in æstivation. Ovary free, rarely coherent, one- or two-celled; ovule solitary, erect, or suspended; stigmas one or two, simple or bifid. Fruit an indehiscent nut, surrounded by the persistent pericarp, or a samara, or a syconus, or a sorosis. Seed solitary, erect, suspended or pendulous, albuminous or exalbuminous; embryo straight, or curved, or spiral; radicle superior. Herbs, shrubs, or trees, with alternate, stipulate leaves, which are usually hispid or scabrous. This order has been divided into the following sub-orders:

Sub-order 1. *Artocarpeæ*, the Bread Fruit Tribe. Trees or shrubs, with leaves often rough; filaments generally erect in æstivation; fruit often a sorosis; seed erect or pendulous, albuminous; embryo straight; juice milky. Natives of tropical regions. The typical genus of this sub-order is Artocarpus, one species of which, A. incisa, furnishes the bread fruit, so valuable to the inhabitants of tropical regions. All parts of the tree are applied to some valuable purpose. Some of the Artocarpæ furnish a

palatable milky juice, as in the Cow-tree of Demerara (Galactodendron utile). The celebrated Bohun-upas poison of Java is obtained from Antiaris toxicaria.

Sub-order 2. *Moreæ*, the Mulberry Tribe. Trees or shrubs, with milky or yellow juice, alternate leaves with deciduous stipules convolute in the bud, and the flowers spiked on (or inclosed in) a receptacle, becoming succulent in fruit. Styles or stigmas two. Seed amphitropous, with a curved embryo in copious albumen. Natives of temperate and tropical regions. The principal plants of this tribe are the figs and the mulberries. The common fig is the fruit of Ficus carica. F. indica is the well known Banyan tree of India, and F. religiosa the Pippul tree of the same country. Large quantities of caoutchouc are derived from F. elastica. F. sycamorus is probably the sycamore of the Scriptures. The genus Morus has numerous representatives, only one of which is indigenous to the United States. This is M. rubra or the red mulberry. M. nigra or the European black mulberry is the sycamine of the Bible. Morus alba or white mulberry (of which M. multicaulis is a variety), the favorite food of the silkworm, is partly naturalized in the United States. The Paper mulberry (Broussonetia papyrifera), in some favor in this country as a shade tree, is so called from the fact of a kind of paper being made from the inner bark, in its native country, Japan. Maclura aurantiaca, the Osage Orange, or Bois d'arc of the South West, is used for hedges. Fustic is obtained from Maclura tinctoria.

Sub-order 3. *Ulmaceæ*, the Elm Tribe. Rough-leaved trees or shrubs; filaments erect in æstivation; fruit one- to two-celled, samaroid or drupaceous; seed pendulous, usually exalbuminous; embryo straight or curved; juice watery. Natives of the northern and mountainous parts of Europe, Asia, and America. This tribe is represented in the United States by the genera Ulmus and Celtis. The slippery or red Elm is Ulmus fulva, well known for its mucilaginous bark. Celtis crassifolia, Hackberry or sugar berry, is a tree which sometimes attains to a large size.

Sub-order 4. *Cannabineæ*, the Hemp Tribe. Herbs with watery juice, mostly opposite stipulated leaves, and diœcious flowers, the sterile racemed or panicled. Styles two. Seeds orthotropous. Embryo curved without albumen. Occur chiefly in temperate regions. Examples: Humulus and Cannabis. Humulus lupulus, the common Hop, is indigenous both in Europe and America. The hemp fibre is obtained from Cannabis sativa. A variety called C. indica is used in India to produce intoxication. The Haschisch of the Arabians consists of the dried tops and other tender parts of this variety.

Sub-order 5. *Urticeæ*, the true Nettle Tribe. Rough-leaved plants, often with stinging hairs, filaments elastic, and curved in æstivation; fruit an indehiscent nut; seed erect, albuminous; embryo straight; juice watery. They are widely scattered over the globe, and many of them follow the footsteps of man in his migrations. The principal representatives of this family in the United States are Urtica, Pilea, Bœhmeria, Parietaria. Many species of Urtica, as U. urens or common nettle, have stinging hairs. Some

species, as U. cannabina and tenacissima, afford excellent fibres for cordage. Urtica is found of great size in some countries, U. gigantea (Australia) having been known to reach a diameter of from eighteen to twenty-six feet. The Chinese grass cloth is the product of Bœhmeria nivea. Parietaria pennsylvanica is the plant known as Pellitory.

Artocarpus incisa or Bread Fruit (South Sea Islands and tropical countries in general) (*pl.* 72, *fig.* 2); *a*, branch with flowers, leaves, and fruit; *b*, male flower; *c*, three female flowers, the central one in vertical section; *d*, section of female capitulum.

Ficus carica, the Fig (*pl.* 72, *fig.* 1); *a*, branch with figs; *b*, vertical section of the torus; *c*, a male, *d*, a female flower; *e*, an unripe fruit; *f*, a ripe fruit; *g*, a vertical section of the seed.

Morus nigra, black mulberry (European) (*pl.* 72, *fig.* 3); *a*, a branch with fruit; *b*, a male flower; *c*, a female flower; *d*, fruit; *e*, the syconus; *f*, the pericarp; *g*, the seed.

Cannabis sativa, Hemp (*pl.* 72, *fig.* 5); *a*, top of the stalk with male flowers; *b*, a male flower; *c*, a filament; *d*, transverse section of the anther; *e*, pollen grains (*b–e* magnified); *f*, female flower; *g*, pistil magnified; *h*, female flower magnified; *i*, dried pericarp; *k*, the same magnified; *l*, a nut without the hull; *m*, magnified; *n*, cross-section; *o*, vertical section.

Humulus lupulus, the Hop (*pl.* 72, *fig.* 4). A, branch with male flowers; B, branch with female catkins; C, a strobile; *a*, male flower; *b*, female flower; *c–e*, rachis with glands, the two lowest scales and one female flower, the rest removed; *f*, four female flowers; *g*, ovary and pistil; *h*, fruit magnified; *i*, fruit inclosed by perianth; *k–l*, other states of fruit.

Order 55. Euphorbiaceæ, the Spurge Family. Flowers unisexual, sometimes inclosed within an involucre. Perianth lobed, inferior, with various glandular or petaloid, scaly, internal appendages; sometimes the flowers are naked. Male flowers: stamens definite or 00, distinct or monadelphous, or polyadelphous; anthers bilocular, sometimes with porous dehiscence. Female flowers; ovary free, sessile or stalked, one-, two-, three-, or many-celled; ovules solitary or twin, suspended; styles equal in number to the cells, distinct or combined, sometimes 0; stigmas several, or one with several lobes. Fruit usually tricoccous, with the cocci separating in an elastic manner, and opening by two valves, or indehiscent and fleshy. Seeds solitary or in pairs, suspended, often arillate; embryo inclosed in fleshy albumen; cotyledons flat; radicle superior. Trees, shrubs, and herbs, often abounding in acrid milk, with opposite or alternate, often stipulate leaves, sometimes none. Some look on this order as apetalous, with a tendency to develope a corolla, while others consider it polypetalous, with a tendency to have the corolla suppressed. In European plants of the order there are usually no petals present, but in those of tropical countries the corolla is frequently well marked. In the Euphorbias of Britain there is an evident involucre, surrounding a number of achlamydeous male and female flowers, which by Linnæus were looked upon as merely stamens and pistils, and hence the plants were put by him in Dodecandria in place of

Monœcia. The flowers in Euphorbiaceæ vary much in the number of their parts. Sometimes the general peduncle or rachis becomes flattened and leaf-like. The inflorescence is occasionally amentaceous, as in the division Scepaceæ, which is separated, as a distinct but not fully defined order, by Lindley. The plants of the order abound in warm regions, especially in Equinoctial America, where they occur as trees or bushes, or lactescent herbs, and often present the appearance of Cactuses, from which their milky juice at once distinguishes them. They are also found in North America and in Europe. There are about 192 genera arranged in six sub-orders, and over 2500 species.

Tribe 1. *Euphorbieæ*, true Euphorbias. Cells one-seeded. Flowers of the two sexes united in a common involucre, resembling a single flower, naked, a single female with many males. Examples: Euphorbia, &c.

Tribe 2. *Stillingieæ.* Cells one-seeded. Flowers naked or apetalous in amentaceous spikes: one or many in the axil of an often biglandular bract; the males two- to ten-androus. Examples: Stillingia, Styloceras, Hura, Hippomane, &c.

Tribe 3. *Acalypheæ.* Cells one-seeded. Flowers apetalous, calyx valvular in the bud, arranged in clusters along a spike, more rarely in racemes. Examples: Acalypha, Tragia, &c.

Tribe 4. *Crotoneæ.* Cells one-seeded. Flowers apetalous, calyx valvular, or imbricated in the bud, disposed in fascicles, spikes, racemes, or panicles. Examples: Crotonopsis, Siphonia, Croton, &c.

Tribe 5. *Phyllantheæ.* Cells two-seeded. Flowers most generally apetalous, with the calyx imbricated in the bud, solitary or combined in clusters or axillary fascicles. Stamens two to five, rarely more, inserted on the torus in the centre of the flower, free or united. Examples: Phyllanthus, &c.

Tribe 6. *Buxeæ.* Cells two-seeded. Flowers usually apetalous, with the calyx imbricated in the bud, arranged in clusters or axillary fascicles, more rarely in racemes or spikes. Stamens four to six, inserted around a central rudimentary pistil. Examples: Buxus, Savia, &c.

The plants of the order Euphorbiaceæ are acrid and poisonous, this property residing chiefly in their milky juices. That of some species of Euphorbia is collected for medicinal purposes. Valuable oils are also obtained from this order. Thus castor oil is expressed from the seeds of Ricinus communis, a plant which, herbaceous in temperate climates, is a tree in its native locality, India. The seeds of Croton tiglium furnish Croton oil. The fatty matter obtained from the seeds of Stillingia sebifera, the Chinese Tallow Tree, is used in making candles. Cascarilla is the bark of Croton eleutheria and other species. The boxwood in such request by wood engravers is obtained from Buxus sempervirens. The Cassava, or Manioc flour, is a starchy matter (Tapioca), obtained by grinding up the root of Manihot utilissima, and washing this well with water. The juice is highly poisonous, although the washed pulp is both harmless and palatable. The juice of Siphonia elastica contains much caoutchouc, and furnishes

most of that India-rubber which comes in bottles. Gum-lac is derived from Aleurites laccifera, a Ceylon plant.

Euphorbia officinarum, Spurge, Central and South Africa (*pl.* 71, *fig.* 9).

Euphorbia cyparissias, Central Europe (*pl.* 71, *fig.* 8): *a* and *b*, flowers of natural size and magnified; *c*, pistil; *d* and *e*, fruit of natural size and magnified.

Siphonia elastica, caoutchouc tree, South America (*pl.* 71, *fig.* 10): A, branch with flowers; *a*, a flower; *b*, vertical section of ditto; *c*, ovary in cross-section; *d*, ovary; *e*, the ripe fruit.

ORDER 56. EMPETRACEÆ, the Crowberry Family. Flowers unisexual. Perianth bud-like, consisting of persistent imbricated scales, in two or four alternating rows, the inner row often petaloid. Male flowers; stamens two or three, equal in number to the scales in each row, and alternating with the innermost, hypogynous; anthers roundish, dithecal, with longitudinal dehiscence. Female flowers: ovary free, seated on a fleshy disk, three- to six- or nine-celled; ovules solitary, anatropal, ascending; style one; stigma with as many radii as there are ovarian cells. Fruit, a nuculanium, seated within the persistent perianth. Seeds solitary in each nucule, ascending; embryo, in the axis of fleshy albumen; radicle inferior. Heath-like shrubs, with alternate or somewhat verticillate, evergreen, exstipulate leaves. They inhabit chiefly Europe and North America. The fruit of some is slightly acid. Empetrum nigrum, the black Crowberry, is common on the mountains and northern parts of Europe, and the United States. The fruit is watery, and very slightly acid and astringent. Lindley notices four genera and four species. Examples: Empetrum, Corema. Both these genera have North American representatives.

ORDER 57. DATISCACEÆ, the Datisca Family. Flowers unisexual. Male flowers: perianth three- or four-divided. Stamens three to seven; anthers linear, membranous, dithecal, with longitudinal dehiscence. Female flowers: perianth adherent, three- or four-toothed. Ovary inferior, unilocular; ovules 00, anatropal, attached to three or four parietal placentas; styles, as many as the placentas. Fruit, a one-celled capsule, opening at the apex. Seeds 00, strophiolate, with a reticulated spermoderm; albumen 0; embryo straight; cotyledons very short; radicle pointing to the hilum. Herbaceous branched plants or trees, with alternate, exstipulate leaves. They are scattered over North America, various parts of Asia, and the south-eastern part of Europe. Some of the plants are said to be bitter, and others of them have purgative qualities. Lindley mentions three genera and four species. Examples: Datisca, Tetrameles.

ORDER 58. RHIZANTHEÆ, the Rhizogen Family. Flowers usually monœcious or diœcious, sometimes ☿. Perianth more or less perfect, superior, trimerous, tetramerous, or pentamerous; sometimes obsolete or 0. Stamens united, often in a fleshy column, to which the anthers cohere, dithecal, extrorse, opening longitudinally or by pores. Ovary inferior, one- or two-celled; ovules definite or 00. Fruit indehiscent, pulpy, usually unilocular. Seeds, sometimes solitary and pendulous, at other times 00, and attached to

parietal placentas; embryo albuminous or exalbuminous. Leafless, scaly, parasitic plants, having a fungus-like appearance. They are never green, but assume a brown, yellow, or purple color. They are composed chiefly of cellular tissue, with a few scalariform or spiral vessels. They are often stemless, and sometimes are furnished with a creeping rhizome. In their mode of decay they resemble Fungi. Their seeds present a peculiar appearance, resembling spores rather than true seeds. The nature of their embryo is undetermined, and their place in the natural system is still doubtful. Lindley has placed them in a separate class, intermediate between Thallogens and Endogens. They have been divided by him into three distinct orders: 1. *Balanophoraceæ*, male flowers pedicellate; stamens, one to three; filaments and anthers both united; ovule solitary, pendulous; fruit, monospermous. 2. *Cytinaceæ*, flowers in spikes; perianth, three- to six-lobed; anthers sessile on a column, dehiscing by slits; ovules 00, attached to parietal placentas; fruit, polyspermous. 3. *Rafflesiaceæ*, flowers sessile, solitary; perianth, five-lobed, with calli in its throat; anthers attached to a column, dehiscing by pores; ovules 00, attached to parietal placentas; fruit polyspermous. They are natives chiefly of tropical countries, but some extend into temperate climates. They are found in the East Indies, South America, Cape of Good Hope, and the south of Europe. Lindley enumerates twenty-one genera and fifty-three species. Examples: Balanophora, Cynomorium, Cytinus, Rafflesia.

Species of Rafflesia exhibit the largest flowers known, the perianth being sometimes three feet in diameter, and capable of holding six quarts of liquid. They are all parasitic.

ORDER 59. NEPENTHACEÆ, the Pitcher-plant Family. Flowers diœcious. Perianth four-parted, inferior; æstivation imbricated. Male flowers: stamens united in a solid central column; anthers about sixteen, forming a spherical head, extrorse, and with longitudinal dehiscence. Female Flowers: ovary free, four-cornered, four-celled; ovules 00; stigma sessile. Fruit a four-celled, four-valved capsule, with loculicidal dehiscence. Seeds 00, ascending, very minute, fusiform, with a loose testa; nucleus less than the seed, suspended by the chalaza; embryo in the midst of fleshy albumen; cotyledons plano-convex; radicle pointing to the hilum. Herbs, or half-shrubby plants, with alternate leaves, slightly sheathing at the base, having a foliaceous petiole, which forms an ascidium at its extremity, and the lamina in the form of a lid. Natives of swampy ground in the East Indies and China. They have no known properties. The pitchers have been found to contain a solution of binoxalate of potash. Spiral vessels abound in all parts of the pitcher plants; and the woody bundles are without concentric zones. Lindley gives one genus, and six species. Example: Nepenthes.

ORDER 60. ARISTOLOCHIACEÆ, the Birthwort Family. Perianth adherent, tubular, three-cleft, regular, or sometimes very irregular; æstivation valvate or induplicate. Stamens six to twelve, epigynous, distinct or gynandrous. Ovary inferior, three- to six-celled; ovules 00, anatropal, horizontal; style simple, short; stigmas radiating, three to six. Fruit dry or succulent, three- to six-celled. Seeds numerous; embryo very minute, at the base of fleshy

albumen; cotyledons inconspicuous; radicle next the hilum. Herbs or shrubs, often climbing, with alternate, simple, often stipulate leaves, and solitary axillary flowers. Found in abundance in the warm regions of South America, and growing also in the temperate and cold regions of Europe, Asia, and America. There are eight known genera and 130 species. Examples: Asarum, Aristolochia, Heterotropa.

Asarabacca of the Pharmacopœia consists of the dried leaves of Asarum europæum. A. canadense is known as wild ginger. Aristolochia serpentaria or Virginia snake root, is a valuable medicine. It is to be distinguished from the seneca snake root, Polygala senega. Aristolochia sipho, a well-known North American plant, is called Dutchman's pipe, from the grotesque similitude of its leaves. Species of this genus were formerly considered efficacious in certain uterine affections. The flowers of some Aristolochias are remarkable for their size and beauty.

Aristolochia clematitis. Birthwort, a highly poisonous species of central Europe. *Pl.* 58, 59, *fig.* 10: *a* rhizome, with the lower part of the stem; *b*, upper part of the plant; *c*, flower enlarged, partly in section; *d*, cross-section of the flower; *e*, do. of ovary; *f*, seed vessel in longitudinal section; *g*, a seed; *h* and *i*, do. in transverse and longitudinal sections; *k*, embryo magnified.

A. serpentaria. Virginia snake root (*pl.* 58, 59, *fig.* 12); *a* the entire plant; *b*, a seed.

A. sipho, Dutchman's pipe, United States (*pl.* 58, 59, *fig.* 11).

Order 61. Santalaceæ, the Sandalwood Family. Herbs, shrubs, or trees, with entire leaves; the four- to five-cleft calyx valvate in the bud, its tube coherent with the one-celled ovary, which contains two to four ovules (consisting of a cellular nucleus, destitute of any proper integument) suspended from the apex of a stalk-like free central placenta which rises from the base of the cell, but the (indehiscent) fruit always one-seeded. Embryo small, at the apex of copious albumen; radicle directed upwards; cotyledons cylindrical. Stamens equal in number to the lobes of the calyx, and inserted opposite them into the edge of the fleshy disk at their base. Style one. Found in Europe, Asia, America, and New Holland.

Sandalwood, a highly fragrant wood, is derived from Santalum album and other Indian and Polynesian species. North American species of this family are Comandra umbellata (Toad Flax) and Pyrularia oleifera or Buffalo nut, common in the southern United States. Santalum myrtifolium, sandalwood (Java) (*pl.* 69, *fig.* 8).

Order 62. Nyssaceæ, the Tupelo Family. This differs from the Santalaceæ in the solitary ovule suspended from the top of the cell. This family is represented in the United States by the sole genus Nyssa, composed of trees remarkable for the adhesion of their fibres, it being almost impossible to split a block of the wood. The naves of carriage wheels are usually made of the wood of Nyssa multiflora, or Gum tree. Southern species are known as Tupelo, Ogeechee lime, &c., the latter term, however, being applied more correctly to the fruit, which is in great request as a preserve.

Order 63. Homaliaceæ, the Homalia Family. Perianth funnel-shaped,

with five to fifteen divisions, and having usually alternating petaloid segments, and glands or scales in front of the outer divisions. Stamens perigynous, either single or in parcels of three or six, alternating with the outer divisions of the perianth; anthers dithecal, with longitudinal dehiscence. Ovary partly adherent to the tube of the perianth, one-celled; ovules numerous, anatropal, pendulous, attached to two, three, or five parietal placentas; styles three to five, simple, filiform, or subulate. Fruit either baccate or capsular. Seeds small, ovate; embryo in the axis of fleshy albumen; cotyledons leafy; radicle superior. Trees or shrubs with alternate leaves, having deciduous stipules. It contains tropical plants, which do not possess any important properties. Lindley mentions eight genera, including thirty species. Examples: Homalium, Nisa.

Order 64. Samydaceæ, the Samyda Family. Perianth four- to five-divided, usually colored inside; æstivation somewhat imbricate. Stamens inserted into the tube of the perianth, two, three, or four times as many as its divisions, either all fertile, or the alternate ones sterile, shorter, and fringed; filaments monadelphous at the base; anthers erect, ovate, two-celled. Ovary free, one-celled; ovules 00, attached to parietal placentas, semi-anatropal; style one, filiform; stigma capitate or slightly lobed. Fruit a coriaceous, unilocular, three- to five-valved capsule, partially dehiscent. Seeds 00, fixed irregularly on the pulpy inner surface of the valves, with a fleshy arillus, and a hollowed hilum; embryo large, in the midst of oily or fleshy albumen; cotyledons ovate, foliaceous; radicle pointing to the extremity remote from the hilum. Trees or shrubs, with alternate, simple, stipulate leaves, usually having pellucid, round, or linear markings. Natives of tropical regions, chiefly in America. There are five known genera, and eighty species. Examples: Samyda, Casearia.

Order 65. Chailletiaceæ, the Chailletia Family. Perianth five-parted, with an incurved valvate æstivation. Stamens inserted into the base of the perianth, five inner fertile opposite the segments of the perianth, five outer sterile, petaloid, usually with glands at their base; anthers ovate, versatile, dithecal. Ovary free, two- to three-celled; ovules twin, pendulous; styles two to three, distinct or combined; stigmas capitate or obscurely two-lobed. Fruit dry, one-, two-, or three-celled. Seeds solitary, pendulous, exalbuminous; embryo thick; cotyledons fleshy; radicle superior. Trees or shrubs, with alternate, stipulate leaves, and axillary peduncles, often cohering to the petiole. They are natives of the warm parts of Africa and South America. The fruit of Chailletia toxicaria is said to be poisonous. There are four genera, and ten species known. Examples: Chailletia, Tapura.

Order 66. Aquilariaceæ, the Aquilaria Family. Perianth coriaceous, imbricate or tubular, limb four- to five-lobed; æstivation imbricate. Stamens usually ten fertile, alternating with ten sterile, in the form of petaloid scales, sometimes eight or five; filaments inserted into the orifice of the perianth, often united; anthers dithecal, with longitudinal dehiscence. Ovary free, ovate, compressed, two-celled; ovules two, suspended, anatropal; stigma usually sessile, large and simple. Fruit a pyriform, sessile, or

stipitate two-valved capsule, or drupaceous and indehiscent. Seeds two, one on each placenta; pendulous; albumen 0; cotyledons fleshy; hemispherical, radicle straight, superior. Trees, with alternate or opposite, entire, stalked, and exstipulate leaves. They are natives of the tropical regions of Asia. There are six genera noticed, including ten species. Examples: Aquilaria, Gyrinopsis.

ORDER 67. THYMELÆACEÆ, the Mezereum Family, Perianth tubular, colored, four-, rarely five-cleft, inferior; occasionally with scales in its orifice; æstivation imbricate. Stamens perigynous, definite, often eight, sometimes four or two, and then opposite the segments of the perianth; anthers dithecal, with longitudinal dehiscence. Ovary free, one-celled; ovule suspended, anatropal; style one; stigma undivided. Fruit either nut-like or drupaceous. Seed solitary, pendulous; albumen 0, or thin and fleshy; embryo straight; cotyledons plano-convex, or somewhat lobed and shrivelled; radicle superior. Shrubby, rarely herbaceous plants, with alternate, or opposite, entire, exstipulate leaves. Natives of various parts of the world, both in warm and temperate regions. There are two sections of the order: 1. Daphneæ, with hermaphrodite or rarely unisexual flowers, and plano-convex cotyledons. 2. Hernandieæ, with polygamous flowers, and lobed and shrivelled cotyledons. Lindley enumerates thirty-eight genera, including three hundred species. Examples: Daphne (Thymelæa), Passerina, Pimelea, Gnidia, Lagetta, Exocarpus, Hernandia, Inocarpus, Dirca.

The inner bark of Lagetta lintearia exhibits a beautifully reticulated appearance, whence its name Lacebark. The fibrous bark of Dirca palustris is very tough, and is used by the Indians for thongs. This species, known as Leather wood and Wicopy, represents the only North American genus of the family.

Daphne mezereum, the Mezereon, Europe and Northern Asia (*pl.* 58, 59, *fig.* 14); *a*, a branch with flowers; *b*, perianth laid open; *c*, stamen; *d*, section of ovary; *e*, a branch with leaves and fruit; *f*, fruit in longitudinal section; *g*, embryo; *h* (to the right of 14^a), seed.

ORDER 68. PENÆACEÆ, the Sarcocol Family. Perianth colored, salver-shaped, with a four-lobed limb, and with two or more bracts at its base, persistent. Stamens perigynous, either four or eight, alternate with the lobes of the perianth; anthers dithecal, introrse. Ovary superior, four-celled; ovules usually in pairs, collateral, anatropal, ascending or suspended; style simple; stigmas four. Fruit a four-celled, four-valved capsule. Seed erect or pendulous; testa brittle; hilum with a fungus-like aril; nucleus a fleshy mass, without distinction of albumen or embryo. Shrubs, with opposite, entire, exstipulate leaves. They are found at the Cape of Good Hope. They have no known properties of importance. The gum-resin called Sarcocol is said to be produced on the perianth of Penæa sarcocolla, and other species. There are two sections of this order: 1. Penæeæ, æstivation valvate, stamens four, connective fleshy, ovules ascending. 2. Geissolomeæ, æstivation imbricate, stamens eight, connective not fleshy, ovules suspended. There are three known genera, and twenty-one species. Examples: Penæa, Geissoloma.

ORDER 69. ELÆAGNACEÆ, the Oleaster Family. Flowers usually unisexual, rarely hermaphrodite. Male flowers amentaceous, with two to four leaves forming the perianth; stamens three, four, or eight; anthers nearly sessile, dithecal, introrse, and dehiscing longitudinally. In the female and hermaphrodite flowers, perianth tubular, persistent, with an entire or two- to four-toothed limb. Disk fleshy. Ovary superior, one-celled; ovule solitary, ascending, on a short funiculus, anatropal; style short; stigma simple, subulate, glandular. Fruit a crustaceous achænium, inclosed within the enlarged succulent perianth. Seed ascending; embryo straight, surrounded by thin fleshy albumen; cotyledons fleshy; radicle inferior. Trees or shrubs, with alternate or opposite entire exstipulate leaves, which are often covered with scurfy scales. They are found in all parts of the northern hemisphere. Examples: Hippophae, Elæagnus, Shepherdia. Of this latter genus there are two species in the United States: S. canadensis, and S. argentea or Buffalo berry, furnishing a pleasant acid fruit.

Elæagnus angustifolia, Oleaster (Europe and Asia) (*pl.* 58, 59, *fig.* 13); *a*, flowering branch; *b*, flower with an abortive pistil, and displayed or laid open; *c*, anther; *d*, a fertile flower displayed; *e*, pistil; *f*, vertical section of the tube of the perianth and of the pistil; *g*, a ripe fruit; *h*, vertical section of do.; *i*, a leaf showing the scurfy stellated hairs; *k*, a scurf scale much magnified.

ORDER 70. PROTEACEÆ, the Protea Family. Perianth more or less deeply four-divided; æstivation valvate. Stamens perigynous, four (one sometimes sterile), opposite the segments of the perianth; anthers dithecal, with longitudinal dehiscence. Ovary single, superior, unilocular; ovules single or in pairs, anatropal or amphitropal; style simple; stigma undivided, discoid. Fruit dehiscent or indehiscent. Seed exalbuminous, sometimes winged; embryo straight, cotyledons two or more; radicle inferior, next the hilum. Shrubs or small trees, with hard, dry, opposite, or alternate, exstipulate leaves. They are natives principally of Australia and the Cape of Good Hope. The order has been divided into two sections: 1. Nucumentaceæ, with nucumentaceous indehiscent fruit. 2. Folliculares, with follicular dehiscent fruit. Lindley mentions forty-four genera, including 650 species. Examples: Protea, Persoonia, Grevillea, Hakea, Banksia, Dryandra.

The plants of this order exhibit great diversity of appearance, and are in much request as ornamental shrubs. The fruit Guevina avellana yields the Chilian nut, called Avellano.

Protea speciosa, Sugar-bush, Cape of Good Hope (*pl.* 60, 61, *fig.* 1): head of flowers.

Banksia serrata, New Holland (*pl.* 60, 61, *fig.* 2): *a*, the cone of flowers; *b*, a flower; *c*, follicle.

ORDER 71. MYRISTICACEÆ, the Nutmeg Family. Flowers unisexual: perianth trifid, rarely quadrifid, in the female deciduous; æstivation valvate. Stamens, three to twelve; filaments combined into a cylinder; anthers united or distinct, dithecal, extrorse, dehiscing longitudinally. Ovary free, composed of one or more carpels, unilocular; ovule solitary, erect, anatropal;

style very short; stigma somewhat lobed. Fruit succulent, one-celled, two-valved. Seed solitary, usually covered by a laciniated arillus; embryo small, orthotropal, at the base of ruminate albumen; cotyledons foliaceous; radicle inferior. Trees with alternate, exstipulate, entire, not dotted leaves. Natives of the tropical regions of Asia and America. There are five known genera, and between thirty and forty species. Example: Myristica.

The most important genus of this order is Myristica, from which the nutmeg is obtained. The principal species, M. moschata, is a native of the Moluccas, but cultivated in many tropical countries. The fruit is a drupe, opening by two valves when ripe, and exhibiting a reticulated arillus, known as mace. Within this is a hard shell, enveloping the kernel or nutmeg. One tree will sometimes yield six pounds of nutmeg. Nutmeg butter or fat is a concrete oil obtained by expressing the fruit.

Myristica moschata, nutmeg (*pl.* 60, 61, *fig.* 3): *a*, a branch with fruit; *b*, ditto, with flowers; *m*, the seed; *k*, vertical section; *h*, ditto, with the embryo; *i*, cross-section.

Order 72. Lauraceæ, the Laurel or Bay Family. Perianth, with four or six divisions, which are usually in two rows, the limb sometimes obsolete; æstivation imbricate. Stamens perigynous, definite, often twice as many as the divisions of the perianth, and arranged usually in two rows, those of the inner row (often three) being frequently sterile (staminodia), while those of the outer (often six in number) are fertile; if the inner stamens are fertile they are extrorse, while the outer are introrse; filaments of the inner row, often with glands at their base; anthers, two- to four-celled, cells opening by longitudinal valves. Ovary superior, unilocular; ovule solitary, pendulous; style simple; stigma obtuse. Fruit baccate or drupaceous, naked or covered by the enlarged perianth, peduncle of the fruit sometimes becoming fleshy. Seed solitary, pendulous; albumen 0; embryo inverted; cotyledons large, plano-convex, peltate near the base; radicle very short, superior; plumule conspicuous. Trees with exstipulate, alternate, rarely opposite leaves; sometimes twining, parasitic, and leafless herbs or under-shrubs. They are natives chiefly of the tropical regions of Asia and America. Few are found in Africa. The order has been divided into two sub-orders: 1. Laureæ, true Laurels, trees with leaves. 2. Cassytheæ, Dodder-laurels, climbing parasitic plants, without leaves.

The more elaborate arrangement of this family by Nees d'Esenbeck, gives the following sub-orders: 1. *Cinnamomeæ.* Example: Cinnamomum. 2. *Camphoreæ.* Example: Camphora. 3. *Phœbeæ.* Example: Phœbe. 4. *Perseæ.* Example: Persea. 5. *Cryptocaryeæ.* Examples: Cryptocarya, Adenostemon. 6. *Acrodiclidieæ.* Example: Aydendron. 7. *Nectandreæ.* Example: Nectandra. 8. *Dicypellieæ.* Example: Petalanthera. 9. *Oreodaphneæ.* Example: Oreodaphne. 10. *Flaviflores.* Examples: Sassafras, Benzoin. 11. *Tetranthereæ.* Examples: Laurus, Tetranthera. 12. *Daphnidieæ.* Example: Daphnidium. 13. *Cassytheæ.* Example: Cassytha.

Plants of this family yield many products of importance. Camphor is a

solid volatile oil, sublimed from the distillation of the wood of Camphora officinarum, a native of China and Japan. The cinnamon of commerce is the dried, inner bark from the young twigs of Cinnamomum zeylanicum, indigenous in Ceylon. The ripe fruit yields an oil, known as cinnamon suet, and camphor is distilled from the roots. Cassia bark and buds are furnished by C. cassia. The Avocado, or the alligator's pear, is the fruit of Persea gratissima. Bebeeru-bark is obtained from Nectandra rodioei, a native of British Guiana. Its timber is used in ship-building, under the name of Green-heart. Well-known inhabitants of North America are Sassafras officinale (Laurus sassafras) or sassafras, and Benzoin odoriferum (L. benzoin) or spice-bush. The Victor's Laurel of the ancients is the Laurus nobilis.

Camphora officinarum (L. camphora), the camphor-tree (*pl.* 58, 59, *fig.* 15, *a–c*).

Cinnamomum zeylanicum (L. cinnamomum), the cinnamon tree (*pl.* 58, 59, *fig.* 16); *c*, bark; *d*, structure of the bark; *e*, perianth externally; *f*, the same externally; *g*, stamen; *h*, pistil; *i*, fruit; *k*, sexual apparatus; *l*, stamen. *Fig.* 16, *b*, bark of C. cassia.

Laurus nobilis, the Victor's Laurel (Mediterranean coast) (*pl.* 58, 59, *fig.* 17); *a*, branch with flowers; *b*, umbel with male flowers; *c*, female flowers; *d*, fruit; *e*, male flowers magnified; *f*, stamen; *g*, do. with two- to three-lobed valves; *h*, female flower magnified; *i*, fruit partly in section; *k*, a cotyledon.

Order 73. Begoniaceæ, the Begonia Family. Flowers unisexual. Perianth colored, having usually four divisions in the male flowers, and five or eight in the female, some being smaller than others; æstivation imbricate. Stamens 00, distinct, or united into a solid column; anthers collected in a head, dithecal, with a thick connective, and longitudinal dehiscence. Ovary adherent to the tube of the perianth, winged, three-celled, with three placentas meeting in the axis; ovules 00, anatropal; stigmas three, sessile, two-lobed, somewhat spirally twisted. Fruit a membranous, triangular, winged capsule, dehiscing below in a loculicidal manner. Seeds 00, minute; testa thin and reticulated; albumen 0; embryo oblong; radicle next the hilum. Semi-succulent herbaceous plants and undershrubs, with alternate oblique leaves, having large scarious stipules. They are sometimes called Elephant's ear, from the form of the leaves. They are natives of warm countries, as the East and West Indies, and South America. The stomata on the lower side of the leaves of many of the species of Begonia are arranged in clusters, and exhibit a beautiful appearance under the microscope. There are three genera and 159 known species. Example: Begonia. Plants of this genus are favorites with American horticulturists.

Order 74. Polygonaceæ, the Buckwheat Family. Perianth inferior, divided, often colored; æstivation imbricate. Stamens definite, inserted into the bottom of the perianth; anthers with longitudinal dehiscence. Ovary free, usually formed by three carpels, unilocular; ovule solitary, orthotropal; styles and stigmas equal to the carpels in number. Fruit a nut, usually triangular, naked or covered by the persistent perianth. Seed

erect; albumen farinaceous; embryo anatropal, generally on one side, sometimes in the axis of the albumen; radicle superior. Herbaceous, rarely shrubby plants, with alternate, stipulate, or exstipulate leaves, and often unisexual flowers. They are found in almost all parts of the world, more especially in the temperate regions of the northern hemisphere. They grow in fields, waste grounds, ditches, mountains, &c. The order has been divided into two tribes: 1. Polygoneæ, with loose flowers, embryo usually abaxial, ochreate stipules. 2. Eriogoneæ, with involucrate flowers, embryo axial, leaves generally exstipulate. Lindley enumerates twenty-nine genera, including 490 species. Examples: Polygonum, Rumex, Rheum, Eriogonum.

The species of the typical genus Polygonum are inconspicuous in appearance, and generally stigmatized as worthless weeds. A common species growing in damp yards and other localities, is called smart-weed (P. hydropiper) from its intense acridity. It is said to drive away the small red ant when laid in places infested by this animal. Some species, as P. sagittatum, form almost impenetrable growths in meadows, on account of the sharp-toothed prickles along the angular stem and leaves. The common Buckwheat, Fagopyrum esculentum, is, in all probability, a native of North-western China, and was not known in Europe before the sixteenth century. Species of Rumex form the sheep sorrel of old fields. The most important genus is Rheum or Rhubarb, the root rhubarb being furnished by many species indigenous to Siberia, Thibet, Northern China, and the Himalaya Mountains. Rheum compactum and rhaponticum have acid petioles, in much request for making pies.

Rheum palmatum, Rhubarb (*pl.* 60, 61, *fig.* 4); *a*, the root; *b*, the stem; *c–f*, flowers and fruit in different states.

ORDER 75. PHYTOLACCACEÆ, the Pokeweed Family. Perianth four- to five-partite. Stamens usually perigynous, indefinite, or equal to the segments of the perianth, and alternate with them. Ovary of one or several carpels, distinct or combined; ovule one in each carpel, ascending or erect; styles equal to the carpels in number, terminal or lateral; stigmas simple or divided. Fruit fleshy and dry, indehiscent, sometimes samaroid. Seeds solitary, erect or ascending; embryo straight or curved; albumen mealy or 0; radicle next the hilum. Undershrubs or herbs, with alternate, entire leaves, which are often dotted. They are natives both of tropical and warm countries, and are found in America, Asia, and Africa.

Sub-order 1. *Petiveriaceæ.* Cotyledons convolute. Leaves stipuled. Tropical America.

Tribe 1. *Petiverieæ.* Embryo straight or slightly curved, perisperm none or much reduced. Examples: Sequieria, Petiveria.

Tribe 2. *Rivineæ.* Embryo annular, inclosing a mealy perisperm. Examples: Mohlana, Rivina.

Sub-order 2. *Phytollaccineæ.* Seeds ascending, cotyledons plane, leaves exstipulate.

Tribe 3. *Limeæ.* Testa of membranous grains. South African plants. Examples: Limeum, Gaudinia, &c.

Tribe 4. *Phytolacceæ.* Testa of crustaceous grains. Plants seldom extra-tropical. Examples: Phytolacca, Ercilla, Giesekia, Microtea, &c. The most important North American plant of this family is Phytolacca decandra or Pokeberry. The young shoots are boiled as greens, and the rich purple juice of the berries has been used as red ink, and also in the coloration of wines. The ashes of the young plants contain a large amount of potash.

ORDER 76. CHENOPODIACEÆ or ANTRIPLICES, the Goosefoot Family. Perianth deeply divided, sometimes tubular at the base, persistent without bracts; æstivation imbricate. Stamens inserted into the base of the perianth or hypogynous, opposite to its segments, and equal to them in number, or fewer. Ovary single, superior, or sometimes cohering to the tube of the perianth, one-celled; ovule solitary, attached to the base of the cell; style two- to four-divided; stigmas simple. Fruit membranous, indehiscent, inclosed in the calyx, sometimes fleshy. Seed erect or resupinate; embryo curved, round farinaceous albumen; often like a horse-shoe, or spiral, or doubled together without albumen; radicle next the hilum. Herbs or under-shrubs, with alternate, sometimes opposite, exstipulate leaves, and hermaphrodite or unisexual flowers. They are found in almost all parts of the world, but do not abound in the tropics. Most of the plants are inconspicuous weeds. There are sixty-seven known genera, and 372 species.

Moquin Tandon has divided this family into seven tribes arranged under two sub-orders, the first, with the embryo curved round the albumen (Cyclolobeæ); the other with a spiral embryo and no albumen (Spirolobeæ).

A *Cyclolobeæ.*

Tribe 1. *Anserineæ.* Stem unjointed, with membranous flat leaves. Flowers hermaphrodite, all of the same form. Pericarp free. Seed with two integuments, the outer usually crustaceous. Examples: Chenopodium, Beta, Ambrina, Blitum, &c.

Tribe 2. *Spinacieæ.* Stem like the last. Flowers polygamous or diclinous; males different from the females, or the calyx often reduced to two valves with the fruit compressed, most often free. Seed with a single or double integument. Examples: Atriplex, Spinacia, Obione, Acnida, &c.

Tribe 3. *Camphorosmeæ.* Stem and leaves generally like the last, the leaves rarely fleshy and semicylindrical. Flowers hermaphrodite or polygamous. Pericarp free. Tegument of the seed simple. Examples: Kochia, Camphorosma, &c.

Tribe 4. *Corispermeæ.* Stem unjointed, with coriaceous, flat, linear leaves. Flowers hermaphrodite, all of the same form. Pericarp adherent. Seed embraced by a simple integument which is compounded with the pericarp. Examples: Anthochlamys, Corispermum.

Tribe 5. *Salicornieæ.* Stem jointed, often leafless. Flowers hermaphrodite, all of the same form, lodged in cavities of the rachis or in the articulations. Pericarp free or adherent. Seed with one or two integuments. Example: Salicornia.

B. Spirolobeæ.

Tribe 6. *Suædineæ.* Stem unjointed, with leaves usually fleshy and vermicular. Flowers hermaphrodite, all similar. Pericarp free, rarely adherent. Seed with two integuments, the outer crustaceous. Embryo coiled in a flat spiral. Examples: Suæda, Schangina, &c.

Tribe 7. *Salsoleæ.* Stem jointed or not, with leaves usually cylindrical and fleshy. Flowers hermaphrodite, similar. Pericarp thin, scarcely free. Tegument of the seed simple and membranous. Embryo in a helicoid or conical spiral. Examples: Salsola, Kali, Brachylepis.

Some prominent American genera are Salsola, Suæda, Salicornia, Chenopodium, &c. The ashes of many species furnish carbonate of soda, especially Salsola, Salicornia, and Kochia. The mustard seed of Scripture is Salvadora persica. The common beet, Beta vulgaris, indigenous along the coast of the Mediterranean, belongs to this family; as also Spinacia oleracea or Spinach, and the Peruvian quinoa, Chenopodium quinoa. The American Chenopodiums are known as Lamb's quarter and Goose-foot.

Beta vulgaris, common Beet (*pl.* 60, 61. *fig.* 5); *d*, root with a radical leaf; *b*, a group of flowers; *c*, a fruit.

ORDER 77. AMARANTHACEÆ, the Amaranth Family. Perianth three- to five-partite, hypogynous, scarious, persistent, usually with two bractlets at the base. Stamens hypogynous, either five and opposite the segments of the perianth, or double that number, distinct, or united, sometimes partly abortive; anthers dithecal or monothecal. Ovary superior, single, one-celled; ovules solitary or several, amphitropal, hanging from a free central funiculus; style one or 0; stigma simple or compound. Fruit a utricle or a caryopsis, rarely baccate. Seeds lentiform, pendulous; testa crustaceous; embryo peripherical; albumen farinaceous; radicle next the hilum. Herbs and shrubs, with simple, opposite, or alternate exstipulate leaves; flowers in heads or spikes, usually hermaphrodite. They are natives of tropical and temperate regions. There are thirty-eight known genera, and 282 species. Examples: Amaranthus, Achyranthes, Celosia, Deeringia, Gomphrena.

The plants of this family are of little economical importance; the leaves of some species furnish a great amount of mucilage. Three fourths of all the species are tropical, most of them American. Iresine and Amaranthus are North American representatives. A. hypochondriacus is a common garden flower, known as Prince's feather. Celosia cristata or Cock's comb, a native of China, is frequently cultivated for purposes of ornament.

Celosia cristata, Cock's comb (*pl* 60, 61. *fig* 6); *c*, a flower magnified.

ORDER 78. NYCTAGINACEÆ, the Marvel of Peru Family. Perianth tubular, colored, contracted in the middle, becoming indurated at the base; limb entire, or toothed and deciduous; æstivation plicate. Stamens definite, hypogynous; anthers dithecal. Ovary superior, one-celled; ovule solitary, erect; style one; stigma one. Fruit a caryopsis, inclosed within

the enlarged persistent tube of the perianth. Embryo peripherical; albumen farinaceous; cotyledons foliaceous; radicle inferior. Herbs, shrubs, or trees, with opposite, often unequal, sometimes alternate leaves, and involucrate flowers. They are natives principally of warm regions. Lindley notices fourteen genera, including one hundred species. Examples: Mirabilis (Nyctago), Boerhaavia, Pisonia.

The plants of this order have purgative qualities. Mirabilis jalapa was at one time considered to be the true Jalap plant. Some species of this genus are known as Four-o'clocks, from their blossoming at nearly that hour of the afternoon.

Mirabilis longifolia (Mexico) (*pl.* 60, 61, *fig.* 8); *a*, upper part of the plant; *b*, stamens and pistil at the bottom of the perianth; *e*, ovary; *d*, filament; *c*, upper part of the style with the stigma; *f*, nut; *g*, vertical section; *h*, embryo.

Sub-Class 2. *Corolliflorœ.*

Calyx and corolla present; petals united, bearing the stamens. This sub-class includes the Monopetalæ of Jussieu, and the Gamopetalæ of Endlicher.

Order 79. Plantaginaceæ, the Plantain Family. Calyx four-parted, persistent; æstivation imbricate. Corolla monopetalous, hypogynous, scarious, persistent, with a four-parted limb. Stamens four, inserted into the corolla, and alternate with its segments; filaments long, filiform, folded inwards in the bud; anthers dithecal, versatile. Disk inconspicuous. Ovary free, two- to four-celled; ovules solitary, or in pairs, or 00; style simple, capillary; stigma hispid, simple, rarely bifid. Fruit an operculate capsule, inclosed within the persistent corolla. Seeds sessile, peltate, or erect; spermoderm mucilaginous; embryo in the axis of fleshy albumen, transverse; radicle inferior. Herbs, which are often stemless, with radical ribbed leaves, and spiked hermaphrodite flowers, or solitary unisexual ones. The species are chiefly found in temperate and cool regions. There are three genera noticed by Lindley, including 120 species. Examples: Plantago, Littorella.

The genus Plantago or plantain, is represented by several species in the United States, one of which (P. major), like the hive bee, appears to accompany man in all his migrations.

Plantago major, common plantain, cosmopolite (*pl.* 60, 61, *fig.* 7): *a*, the entire plant; *b*, a flower; *c*, the corolla tube opened; *d*, the pistil; *e*, the pericarp; *f*, the same opened; *g*, a seed; *h*, transverse section of ditto.

Order 80. Plumbaginaceæ, the Leadwort Family. Calyx tubular, persistent, sometimes colored; æstivation plaited. Corolla monopetalous, or pentapetalous, regular. Stamens five, hypogynous when the corolla is gamopetalous, attached to the base of the petals when they are separate. Ovary free, one-celled; ovule solitary, pendulous from a funiculus which arises from the bottom of the cell; styles five, seldom three or four, each bearing a subulate stigma. Fruit a utricle. Seed pendulous; spermoderm

simple; embryo straight, in the axis of mealy albumen; radicle superior. Herbs or undershrubs, with alternate or fasciculate exstipulate leaves, somewhat sheathing at the base; flowers panicled or capitate. They inhabit the sea-shore and salt marshes, chiefly in temperate regions. There are two sections of this order: 1. Plumbagineæ, with a synpetalous corolla and connate styles. 2. Staticeæ, with a pentapetalous corolla and distinct style. Lindley mentions eight genera and one hundred and sixty species. Examples: Plumbago, Statice, Armeria.

Plumbago europea, Toothwort, Southern Europe (*pl.* 60, 61, *fig.* 9): *a*, upper part of the plant; *b*, portion of a leaf magnified; *c*, calyx magnified; *d*, section of flower tube; *e*, stamens and pistil; *f*, anther magnified; *g*, section of the ovary showing the ovule with its long funiculus.

Order 81. Primulaceæ, the Primrose Family. Calyx rarely four-cleft, inferior, or half superior, regular persistent. Corolla monopetalous, hypogynous, rarely perigynous, with the limb five- rarely four-cleft, sometimes 0. Stamens inserted on the corolla, equal in number and opposite to its segments. Ovary free, rarely adherent to the base of the calyx, one-celled; ovules 00, amphitropal; style one; stigma capitate. Fruit a capsule, opening with valves, or with a lid. Seeds numerous, peltate, attached to a free central placenta; embryo straight, inclosed within fleshy albumen, and lying across the hilum. Herbaceous plants, with leaves usually opposite, and frequently radical, exstipulate; flowers on simple or umbellate scapes. They are natives chiefly of temperate and cold regions in the northern hemisphere; some occur in elevated stations in warm countries.

Sub-order 1. *Primuleæ.* Pod entirely free from the calyx, opening by valves. Examples: Primula, Dodecatheon, Trientalis, Lysimachia, Cyclamen, &c.

Sub-order 2. *Anagallideæ.* Pod free from the calyx, opening all round by a transverse line, the top falling off by a lid. Example: Anagallis.

Sub-order 3. *Samoleæ.* Pod half adherent to the calyx. Example: Samolus.

Sub-order 4. *Hotonieæ.* Pod opening by valves. Seeds fixed by the base, anatropous. Example: Hottonia.

All the genera above enumerated are found in the United States, except Cyclamen. This is known in Europe as sow-bread, on account of the partiality shown to the tuberoid, partly subterraneous stems, by hogs. The cowslip and the primrose are respectively Primulea veris and vulgaris; the oxlip P. elatior.

Anagallis arvensis, Pimpernel, indigenous in Europe, introduced into America (*pl.* 60, 61, *fig.* 10): *a*, the plant; *b*, the calyx magnified; *c*, portion of the corolla magnified; *d*, stamen; *e*, pistil; *f*, pod, showing the manner of opening; *g*, a seed magnified; *h*, transverse section of ditto.

Lysimachia vulgaris, Loose-strife, Europe (*pl.* 60, 61, *fig.* 13): *a*, branch with flowers; *b*, extremity of calyx-lobe magnified; *c*, stamens; *d*, capsule in the calyx; *e*, a seed; *f* and *g*, transverse and longitudinal section of ditto.

Cyclamen europæum, Sow-bred (*pl.* 60, 61, *fig.* 12): *a*, the plant; *b*,

calyx and pistil; *c*, a portion of the corolla, with two stamens; *d*, a stamen magnified; *e*, cross-section of the anther; *f*, vertical section of the ovary; *g*, pericarp; *h*, a seed magnified.

Dodecatheon integrifolium, American cowslip, United States (*pl.* 60, 61, *fig.* 11): *a*, lower part of the plant; *b*, scape; *c*, stamens separated; *d*, pistil; *e*, fruit.

ORDER 82. LENTIBULARIACEÆ, the Bladder-wort Family. Calyx inferior, divided, persistent. Corolla monopetalous, hypogynous, irregular, bilabiate, usually spurred. Stamens two, inserted into the base of the corolla, and included; anthers monotheeal, sometimes contracted in the middle. Ovary free, composed of two carpellary leaves, unilocular; ovules 00, anatropal; placenta free, central; style one, very short; stigma bilamellar. Fruit a one-celled capsule, dehiscing transversely, or by an apicilar cleft. Seeds numerous, minute, exalbuminous; embryo sometimes undivided; radicle next the hilum. Aquatic or marsh herbaceous plants, with radical leaves, which are sometimes compound, and bear little bladders or ampullæ. Flowers often on scapes. They are found in all parts of the world, and abound in the tropics. Lindley enumerates four genera, including one hundred and seventy-three species. Examples: Utricularia, Pinguicula.

ORDER 83. ACANTHACEÆ, the Acanthus Family. Calyx with four or five divisions, equal or unequal, occasionally multifid, or entire and obsolete, persistent. Corolla monopetalous, hypogynous, usually irregular, with the limb ringent or bilabiate, or rarely unilabiate, sometimes nearly equal, deciduous. Stamens inserted on the corolla, usually two, sometimes four, didynamous, the shorter ones being occasionally sterile; anthers one- or two-celled, with longitudinal dehiscence. Disk glandular. Ovary free, two-celled; placentas adhering to the axis; ovules two or more in each cell, curved; style one; stigma two-lobed, rarely entire. Fruit a two-celled capsule, dehiscing by two elastic valves, in a loculicidal manner. Seeds two or many in each cell, sometimes solitary, roundish, attached to hard, persistent, hooked or subulate, ascending processes of the placenta; testa loose; albumen 0: embryo curved or straight; cotyledons large, leafy; radicle cylindrical, next the hilum. Herbaceous plants or shrubs, with opposite, exstipulate, simple leaves, and bracteated flowers, two or three large leafy bracts accompanying each flower. They abound in tropical regions. The order has been divided into three tribes by Nees d'Esenbeck, as follows:—

Tribe 1. *Thunbergieæ:* placental processes, in the form of a hard cup supporting the seed. Example: Thunbergia.

Tribe 2. *Nelsonieæ*: placental processes contracted into a papilla, bearing the small and pitted seed. Example: Nelsonia.

Tribe 3. *Echmatacanthi.* Placental processes hooked. Of this tribe there are seven sections. 1. *Hygrophiles.* Example: Hygrophila. 2. *Ruellieæ.* Examples: Dipteracanthus, Ruellia. 3. *Barlerieæ.* Example: Barleria. 4. *Acantheæ.* Example: Blepharis. 5. *Justicieæ.* Example: Justicia. 6. *Dicliptereæ.* Example: Blechum. 7. *Andrographideæ.*

Example: Erianthera. Prominent genera of the United States are Dianthera and Dipteracanthus. There are about 105 genera, and 750 species in the entire family, according to Lindley.

Acanthus mollis, Bear's claw (Southern Europe) (*pl.* 62, *fig.* 2); *a*, portion of the flower, showing the stamens and the two lateral bracts; *b*, anther; *c*, pistil; *d*, seed vessel; *e*. section of the seed.

Ruellia formosa (*pl.* 62, *fig.* 1); *a*, calyx; *b*, pistil.

ORDER 84. VERBENACEÆ, the Vervain Family. Calyx tubular, persistent, inferior. Corolla monopetalous, tubular, hypogynous, deciduous, limb usually irregular; æstivation imbricated. Stamens usually four, didynamous, rarely equal, sometimes two. Ovary free, two- to four-celled; ovules usually four, erect or pendulous, anatropal or amphitropal; style one, terminal; stigma bifid or entire. Fruit nucamentaceous or baccate, composed of two or four achænia united. Seeds one to four; albumen 0 or fleshy; embryo straight; radicle either inferior or superior. Trees or shrubs, rarely herbs, with opposite or alternate exstipulate leaves. The order has been divided into three sub-orders:—1. *Myoporineæ*, anthers two-celled, seed pendulous, radicle superior; natives of the southern parts of America and Africa, and of Australia. 2. *Verbeneæ*, anthers two-celled, seed erect, radicle inferior; natives both of the tropical and temperate regions of America, and found also in Asia and Europe. 3. *Selagineæ*, anthers one-celled, seed pendulous, radicle superior; natives chiefly of the Cape of Good Hope, but some are European. There are seventy-five known genera, and upwards of 770 species. Examples: Myoporum, Avicenna, Verbena, Vitex, Tectona, Selago, Globularia.

Some American representatives of this family are Verbena, Phryma, and Lippia. The fragrant Verbena of horticulturists is the Aloysia citriodora. Tectona grandis furnishes the teak wood of India.

Vitex agnus castus (Europe) (*pl.* 62, *fig.* 5, *a–i*).

ORDER 85. LABIATÆ, the Mint Family. Calyx tubular, inferior, regular or bilabiate, persistent. Corolla monopetalous, hypogynous, bilabiate; upper lip entire or bifid, lower three-lobed. Stamens four, didynamous, sometimes two by abortion, inserted into the corolla, and alternate with the lobes of the lower lip; anthers two-celled, or one-celled by abortion, or by absorption of the septum; connective sometimes large and distractile. Disk fleshy. Ovary free, deeply four-lobed; ovules four; style one, basilar; stigma bifid, usually acute. Fruit consisting of one to four achænia, inclosed within the persistent calyx. Seeds erect; albumen either 0, or in small quantity; embryo erect; cotyledons flat; radicle inferior. Herbs or undershrubs, with tetragonal stems, opposite exstipulate leaves, and cymose inflorescence, the flower being often in verticillasters. Linnæus looked upon the fruit as naked seeds, and hence included many of the plants in the order Gymnospermia of his Didynamous class. They are natives chiefly of temperate regions. Lindley mentions 125 genera, including 2,350 species.

Tribe 1. *Ocimoideæ*. Stamens declined. Ex.: Lavandula.

Tribe 2. *Menthoideæ.* Stamens straight or diverging. Tube of the corolla hardly exceeding the calyx, with four or five nearly equal divisions. Ex.: Isanthus, Mentha, Lycopus.

Tribe 3. *Monardeæ.* Stamens ascending; the superior, abortive, or synantherous; the inferior with linear anthers united or halved. Ex.: Salvia, Monarda, Blephilia.

Tribe 4. *Satureineæ.* Stamens straight, diverging or slightly ascending; the inferior longest. Anthers not bifid. Tube of the corolla without the ring, scarcely exceeding the calyx and the imbricated bracts; the limb slightly bilabiate, with flat divisions. Ex.: Cunila, Thymus, Origanum, &c.

Tribe 5. *Melissineæ.* Stamens ascending; the inferior longest. Corolla bilabiate with flat divisions (upper lip rarely arched). Calyx generally traversed by thirteen nervures, bilabiate. Ex: Hedeoma, Melissa, &c.

Tribe 6. *Scutellarineæ.* Stamens ascending; the inferior longest. Corolla bilabiate; upper lip arched. Upper lip of the calyx entire or truncate. Ex.: Prunella, Scutellaria.

Tribe 7. *Prostanthereæ.* Stamens diverging or ascending, the lower longest or abortive. Anthers often dimidiate. Corolla with the tube short, campanulate above, the flat divisions disposed nearly in two lips. Achænia coriaceous, reticulated, with the style persistent. Plants entirely Australasian. Ex.: Chilodia, &c.

Tribe 8. *Nepeteæ.* Superior stamens projecting most. Ex.: Lophanthus, Nepeta, Dracocephalum, Cedronella.

Tribe 9. *Stachydeæ.* Stamens ascending, the inferior longest. Corolla bilabiate. Calyx not thirteen nerved. Achænia dry, almost smooth. Ex.: Synandra, Lamium, Galeopsis, Stachys, Betonica, Ballota, &c.

Tribe 10. *Prasieæ.* Stamens ascending, the inferior the longest. Corolla bilabiate. Achænia fleshy. Ex: Prasium, &c.

Tribe 11. *Ajugordeæ.* Stamens ascending, projecting considerably beyond the upper lip, which is very short or bifid, or declined; achænia with reticulated furrows. Ex.: Teucrium, Trichostema.

Most of the genera adduced above represent this order in the United States. Plants of the order Labiatæ are generally fragrant and aromatic, none of them poisonous or injurious. Various species of Mentha or Mint yield volatile oils. Peppermint is M. piperita; Spearmint, M. viridis; and Pennyroyal, M. pulegium. Lavender is obtained from various species of Lavandula, one of which (Spica latifolia) furnishes oil of spike. Sweet marjoram is Origanum majorana; hoarhound, Marrubium vulgare; thyme, a species of Thymus; savory, of Satureia; sage, of Salvia; basil, of Ocymum. The patchouli perfume is derived from Pogostemon patchouli.

Galeopsis tetrahit, Hemp-nettle (United States and Europe) (*pl.* 62, *fig.* 7): *a*, calyx; *b* and *c*, corolla; *d*, fruit calyx; *e*, a nut.

Betonica officinalis (Europe) (*pl.* 62, *fig.* 6). The various figures to all of which 6 is attached need no special explanation.

Order 86. Scrophulariaceæ, the Figwort Family. Calyx divided into four or five parts, unequal, persistent, inferior. Corolla monopetalous, more or less irregular and bilabiate, or personate, sometimes spurred or saccate

at the base; æstivation imbricate. In the bud, the flowers are regular. Stamens usually 4, didynamous, rarely 5, sometimes 2; anthers bilocular or unilocular by abortion or adhesion. Ovary free, two-celled; ovules usually 00; style simple; stigma two-lobed, rarely entire. Fruit capsular, rarely fleshy, dicarpellary, two-celled, two- to four-valved, opening by septicidal or loculicidal dehiscence, rarely by pores or lids, the dissepiments becoming finally loose in the centre. Placentas attached to the dissepiment, and sometimes in the mature fruit becoming central. Seeds definite or 00; embryo straight or slightly curved, included within fleshy albumen. Herbs, undershrubs, or shrubs, with opposite, whorled, or alternate leaves. They are found generally distributed over the globe, both in cold and warm regions. The order has been divided by Bentham into three sections:

Sub-order 1. *Salpiglossideæ.* Segments of the corolla equal with induplicate or bilabiate æstivation, the biloped lip external. Inflorescence centrifugal. This suborder contains but a single tribe—1. *Salpiglosseæ.* Examples: Duboisia, Schizanthus. Principally South American.

Sub-order 2. *Antirrhinideæ.* Corolla bilabiate, the bilobed lip external. Inflorescence centripetal or compound. *Tribe* 2. *Calceolarieæ.* Example: Calceolaria. *Tribe* 3. *Verbasceæ.* Examples: Verbascum, Celsia. *Tribe* 4. *Hemimerideæ.* Examples: Alonsia, Colpias, &c. *Tribe* 5. *Antirrhinieæ* Examples: Linaria, Antirrhinum. *Tribe* 6. *Cheloneæ.* Examples: Chelone, Collinsia, Pentstemon, Scrophularia. *Tribe* 7. *Escobedieæ.* Examples: Alectra, Escobedia, &c. *Tribe* 8. *Gratioleæ.* Examples: Diplacus, Conobæa, Gratiolo, Ilysanthus, Hemianthus, Herpestis.

Sub-order 3. *Rhinanthideæ.* Corolla bilabiate, the bilobed lip never exterior in æstivation. Inflorescence centripetal or compound. *Tribe* 9. *Sibthorpieæ.* Examples: Sibthorpia, Limosella. *Tribe* 10. *Buddleieæ.* Example: Bryodes. *Tribe* 11. *Digitaleæ.* Examples: Digitalis, Synthyris. *Tribe* 12. *Veroniceæ.* Example: Veronica. *Tribe* 13. *Buchnereæ.* Example: Buchnera. *Tribe* 14. *Gerardieæ.* Examples: Seymeria, Gerardia.* *Tribe* 15. *Euphrasieæ.* Examples: Castilleja, Schwalbea, Euphresia, Rhinanthus, Pedicularis, Melampyrum.

Most of the above-mentioned genera have North American representatives. The entire order, according to Lindley, contains 176 genera and 1814 species. Some plants of the order are poisonous. The most important medicinal species is Digitalis purpurea, or Fox-glove. The common Mullein (Verbascum thapsus) has been introduced into America from Europe, as also Linaria vulgaris, Toad-flax, an abundant yellow weed.

Calceolaria corymbosa, Slipperwort (Chili) (*pl.* 62, *fig.* 9); *c*, calyx; *d*, vertical section of flower.

Digitalis purpurea, purple Fox glove (Europe) (*pl.* 62, *fig.* 8); A, extremity of stalk; B, central portion of do.; *a*, inside of the flower (in part) magnified, with the stamens; *b* and *c*, anthers; *d*, calyx with pistil; *e*, seed vessel; *f*, do. burst open; *g*, do. in cross-section; *h*, placenta; *i*, seed; *k*, a seed magnified; *l* and *m*, sections of do.

Verbascum thapsus, Mullein (Europe) (*pl.* 62, *fig.* 10); *b*, calyx; *c*, corolla with the five stamens; *d*, smooth stamen; *e*, hairy stamen.

Pedicularis palustris, Lousewort (Europe) (*pl.* 60, 61, *fig.* 15); *a*, upper part of the plant; *b*, root; *c*, lower lip of the corolla; *d*, section of the corolla with the stamens; *e*, pistil.

Veronica officinalis, Speedwell (central Europe) (*pl.* 60, 61, *fig.* 14).

ORDER 87. OROBANCHEÆ, the Broom-rape Family. Calyx divided, persistent, inferior. Corolla monopetalous, hypogynous, irregular, usually bilabiate, persistent; æstivation imbricated. Stamens four, didynamous. Disk fleshy. Ovary free, one-celled, composed of two carpels which stand fore and aft, with two or more parietal placentas; ovules 00; style one; stigma two-lobed, each of the lobes belong half to each carpel. Fruit capsular, inclosed within the withered corolla, one-celled, two-valved. Seeds 00, minute; embryo very minute, at one end of fleshy albumen. Herbaceous parasitical plants, having scales in place of leaves. They are natives of Europe, more especially the southern parts, and of Asia, North America, and the Cape of Good Hope. Lindley gives twelve genera, and 116 species. Examples: Orobanche, Lathræa, Epiphegus, Conopholis, Aphyllon.

The plants of this order are generally destitute of green foliage, with lurid yellowish or brownish scales instead. They are mostly parasitic on the roots of various other species.

Lathræa squamaria (Europe) (*pl.* 60, 61, *fig.* 16); upper and lower part of the plant; *a* and *b*, calyx; *c*, corolla; *d*, anthers; *e*, pistil; *f*, pericarp, &c.

ORDER 88. SOLANACEÆ, the Nightshade Family. Calyx inferior, five-, rarely four-partite, persistent. Corolla monopetalous, hypogynous, with the limb five-, rarely four-cleft, regular, or somewhat unequal, deciduous; æstivation plicate or imbricated. Stamens inserted on the corolla, equal in number to the corolline sehments, and alternate with them; anthers with longitudinal or porous dehiscence. Ovary usually two-celled, sometimes four-, five-, or many-celled; ovules indefinite; style continuous; stigma simple. Fruit with two, four, or more cells, rarely unilocular; either a capsule dehiscing in a septicidal or circumscissile manner, and having a double dissepiment parallel to the valves, or a berry with the placentas adhering to the dissepiment, or a nuculanium with five or more nucules. Seeds 00; embryo straight or curved, often excentric, lying in fleshy albumen; radicle next the hilum. Herbs or shrubs, with alternate leaves. Natives of most parts of the world, but abundant in the tropics. The order has been divided into two sections, which are not, however, well defined.

A. *Curvembryeæ.*

(Embryo curved, with semi-cylindrical cotyledons.)

Tribe 1. *Nicotianæ.* Capsule bilocular, separating into two valves by septicidal dehiscence. Examples: Nicotiana, Petunia.

Tribe 2. *Datureæ.* Capsule or berry incompletely four-locular. Example: Datura.

Tribe 3. *Hyoscyameæ.* Capsule bilocular, opening by a circular slit. Example: Hyoscyamus.

Tribe 4. *Solaneæ.* Berry two-celled or more, or fruit dry, indehiscent. Examples; Nicandra, Physalis, Solanum, Lycopersicum, Atropa, Capsicum, Mandragora, &c.

B. Rectembryeæ.

(Embryo straight, cotyledons foliaceous.)

Tribe 5. *Cestrineæ.* Berry bilocular. Example: Cestrum.

Tribe 6. *Vestieæ.* Capsule bilocular. Examples: Vestia, Sessea.

Of the entire order, there are about sixty-six genera and 950 species. Many of these occur in the Americas. The general qualities of Solanaceæ are narcotic, which, when developed to a great degree, impart highly poisonous properties. Some of these are Solanum dulcamara (Bittersweet), Atropa belladonna (Belladonna), Hyoscyamus niger (Henbane), Datura stramonium (Jimson weed), Nicotiana tabacum (Tobacco.) The most important plant of this order is the potatoe (Solanum tuberosum). This invaluable tuber is indigenous to the South American Cordilleras, whence it was brought to Europe, and ultimately distributed all over the world. It is now cultivated in Europe as far north as Hammerfest in Lapland, lat. 71°., and in the Faroes, as also in the lower plateaus of India, in China, Japan, Australasia, and New Holland. The precise period of its introduction into Europe is unknown, towards the end of the sixteenth century in all probability; it was first carried from Virginia to Ireland in 1586. Other species of Solanum (S. melongena, and ovigerum,) furnish the Melongena or egg plant. The Tomato is the fruit of Lycopersicum esculentum. As already mentioned, species of Nicotiana furnish tobacco. The one generally cultivated in the United States is N. tabacum; the best Havannah cigars are made from N. repanda. Syrian, Turkish, and Persian tobacco are furnished by different species. The mandrake of English authors is the forked root of Mandragora officinalis. The Cayenne peppers or Chillies are derived from species of Capsicum.

Hyoscyamus niger, Henbane (Europe) (*pl.* 63, *fig.* 1); *a*, the corolla opened and reduced; *b*, pistil; *c*, pericarp; *d*, cross-section of do.; *e*, a seed.

Nicotiana tabacum, Tobacco (*pl.* 62, *fig.* 11); A, top of the plant; B, an inferior and C a superior leaf; *a*, an opened flower; *b*, capsule; *d*, do. burst; *c*, a cross-section of do.

Datura stramonium, Jimson weed (corruption of Jamestown weed) (East Indies) (*pl.* 63, *fig.* 2); *a*, corolla opened; *b*, pistil; *c*, cross-section of the pod; *d*, a seed magnified.

Atropa belladonna, Belladonna (Europe) (*pl.* 63, *fig.* 3); *a*, expanded corolla; *b*, anther; *c*, pistil; *d*, stigma magnified; *e*, fruit; *f*, cross-section of do.; *g*, seed; *h*, vertical section of do.

Solanum dulcamara, Climbing nightshade (Europe) (*pl.* 63, *fig.* 4).

Capsicum annuum, Cayenne pepper (South America) (*pl.* 63, *fig.* 5).

Order 89. Boraginaceæ, the Borage Family. Calyx persistent, four- to five-divided. Corolla gamopetalous, hypogynous, usually regular, five-,

rarely four-cleft; æstivation imbricated. Stamens inserted on the corolla, equal in number to its segments and alternate with them. Ovary usually four-lobed, quadrilocular; ovules four, each attached to the lowest point of the cavity, amphitropal; style simple, basilar (terminal in Ehretieæ and Heliotropieæ); stigma simple or bifid. Fruit consisting of two to four distinct achænia (succulent and consolidated in Ehretieæ.) Seed exalbuminous, or with thin albumen; radicle superior; cotyledons plano-convex. Herbs, shrubs, or trees, with terete stems, alternate rough, exstipulate leaves, and flowers generally in scorpioidal (gyrate) cymes. On account of the asperities in the leaves, the plants have sometimes been called Asperifoliæ.

Sub-order 1. *Ehretieæ.* Style terminal. Almost entirely tropical. *Tribe* 1. *Tournefortieæ.* Seeds with a perisperm. Examples: Ehretia, Tournefortia, &c. *Tribe* 2. *Heliotropeæ.* Seeds without perisperm. Examples: Heliotropium, Schleidenia.

Sub-order 2. *Boragineæ.* Style gynobasic. No perisperm. Inhabitants of temperate regions. *Tribe* 3. *Anchuseæ.* Carpels adnate to the receptacle. Examples: Onosmodium, Echyum, Lycopsis, Symphytum, Mertensia, Lithospermum, Myosotis, &c. *Tribe* 4. *Cynoglosseæ.* Carpels adnate to the base of the style. Examples: Cynoglossum, Echinospermum.

The genera adduced of the two last tribes all have North American species. There are in the entire order about 67 genera and 200 species. Some species of Heliotropium are eminent for their fragrance. Alkanet root, which yields reddish-brown die, is the product of Anchusa tinctoria. Myosotis palustris is the Forget-me-not. Mertensia (Pulmonaria) virginica, or Lungwort, is one of our earliest spring flowers.

Borago officinalis, Borage, Europe and Asia (*pl.* 63, *fig.* 6); *a*, calyx with pistil; *b*, division of corolla with stamen; *c*, one of the scaly appendages of the corolla; *d*, a stamen; *e*, ditto from before: *f*, the nutlets; *g*, one of these magnified.

Order 90. Cordiaceæ, the Cordia Family. Calyx four- or five-toothed, inferior. Corolla monopetalous, four- or five-cleft, regular. Stamens inserted on the corolla, alternate with its segments; anthers versatile. Ovary free, four- to eight-celled; ovules solitary, pendulous, anatropal; style continuous; stigma four- to eight-cleft. Fruit drupaceous, four- to eight-celled. Seed exalbuminous, pendulous from the apex of the cell by a long funiculus, upon which it is turned back; radicle superior; cotyledons plaited longitudinally. Trees with alternate, rough, exstipulate leaves, and panicled flowers. They are chiefly natives of warm countries. Some yield edible fruits; their bark is occasionally bitter, tonic, and astringent, and their wood is used for various economical purposes. The succulent mucilaginous fruits of Cordia myxa, and sebestena receive the name of Sebesten Plums. There are 11 genera enumerated by Lindley, including 180 species. Examples: Cordia, Varronia.

Order 91. Convolvulaceæ, the Convolvulus Family. Calyx five-divided, persistent, imbricated, often bracteated. Corolla monopetalous, hypogynous, deciduous, regular; limb five-lobed, with a plaited or imbricated

æstivation; tube sometimes with scales, alternate with the lobes of the limb. Stamens five, inserted in the base of the corolla, and alternate with its lobes. Disk annular, hypogynous. Ovary free, two- to four-celled, rarely by abortion one-celled; ovules definite, erect, when more than one, collateral; style one, usually bifid, rarely two; stigmas obtuse or acute. Fruit succulent or capsular, one- to four-celled, with septifragal and septicidal, or circumscissile dehiscence. Seeds albuminous; embryo curved or spiral; cotyledons corrugated or inconspicuous; radicle inferior. Herbs or shrubs, usually twining, sometimes parasitical, often with a milky juice, and with alternate, undivided, or lobed, exstipulate leaves, rarely leafless. They occur chiefly in tropical and temperate regions. The order has been divided into two sub-orders.

Sub-order 1. *Convolvuleæ*, true Bindweeds, leafy plants with the corolline tube not scaly, embryo curved, cotyledons conspicuous.

Sub-order 2. *Cuscuteæ*, Dodders, leafless parasites, having scales on the corolline tube, embryo spiral and filiform, cotyledons inconspicuous. There are forty-five genera and upwards of 700 species. Examples: Calystegia, Convolvulus, Ipomœa, Exogonium, Dichondra, Cuscuta.

This order contains plants of considerable economical importance. Jalap is obtained from Exogonium purga (Convolvulus jalapa) a native of Mexico; Convolvulus scammonia yields scammony. The root of Batatas edulis (Convolvulus batatas) is known as the sweet potatoe.

Exogonium purga, Jalap plant, Mexico (*pl.* 63, *fig.* 7); *a*, pistil; *b*, capsule; *c*, a seed.

Order 92. Hydrophyllaceæ, the Water-leaf Family. Herbs, commonly hairy, with mostly alternate and cut-lobed leaves, regular five-merous, and five-androus flowers, as in the Borage Family, but the ovary ovoid and entire, one-celled, with two parietal few- or many-ovuled placentas, which usually project into the cell, and often line it like an interior pod. Style two-cleft above. Pod globular, two-valved, few-seeded. Seeds reticulated or pitted, amphitropous, with a minute embryo in cartilaginous albumen. Flowers chiefly blue or white, in one-sided cymes or racemes, which are coiled from the apex when young; pedicels bractless. Examples: Hydrophyllum, Phacelia, Eutoca. All North American.

Order 93. Diapensiaceæ, Mountain-box Family. Dwarf and tufted, somewhat shrubby plants (only two in number), with small and evergreen heath-like foliage, the fruit agreeing with Polemoniaceæ, as do the flowers, except in the following points, viz. Calyx of five separate and strongly imbricated persistent sepals, like the bracts. Stamens five, inserted in the very sinuses of the bell-shaped corolla; filaments short and flat; anthers opening transversely across the cells on the inside. Style single, stigma minutely three-lobed. Examples: Diapensia and Pyxidanthera, both low, evergreen shrubs. Diapensia lapponica is found in the Alpine summits of Mounts Washington, and Marcy or Tahawus.

Order 94. Polemoniaceæ, the Phlox Family. Calyx inferior, five-divided, persistent, sometimes irregular. Corolla regular, rarely irregular, five-lobed. Stamens five, inserted on the middle of the tube of the corolla, and alternate

with its segments; pollen often blue. Disk lobed: ovary free, three-celled; ovules anatropal or amphitropal; style simple; stigma trifid. Fruit, a three-celled, three-valved capsule, with septifragal dehiscence. Seeds angular, or oval, or winged, often enveloped in mucus, containing spiral threads, ascending in a single or a double row; embryo straight, in the axis of a fleshy or horny albumen; cotyledons foliaceous, elliptical, or cordate; radicle inferior, next the hilum. Herbaceous or climbing plants, with opposite or alternate, simple or compound leaves. They inhabit temperate countries chiefly, and they abound in the north-western part of America. There are 17 genera enumerated by Lindley, including 104 species. Examples: Polemonium, Phlox, Cobæa.

Polemonium cœruleum, Jacob's Ladder, Europe (*pl.* 63, *fig.* 8); *a*, the corolla expanded; *b*, calyx; *c*, pistil; *d*, capsule; *e*, cross-section of ditto; *f*, a seed.

Order 95. Bignoniaceæ, the Bignonia Family. Calyx divided or entire, sometimes spathaceous.. Corolla monopetalous, hypogynous, usually irregular, four- or five-lobed. Stamens five and unequal, or four and didynamous, some of them occasionally sterile; anthers bilocular. Disk annular or glandular. Ovary superior, one- or two-celled, each cell being often spuriously divided; ovules indefinite; style one; stigma bilamellar, or two- to four-cleft, or entire. Fruit, a two-celled (sometimes spuriously four-celled) and two-valved capsule, occasionally succulent. Placentas, parietal, sometimes extending to the centre, and forming a spurious dissepiment, which finally separates, bearing the seeds. Seeds winged or wingless, often flat and compressed, exalbuminous; embryo straight; radicle next the hilum. Trees, shrubs, or herbs, with opposite, rarely alternate, exstipulate leaves. They abound generally in tropical regions, but some of them are widely distributed. The order has been divided into four sub-orders:

Sub-order 1. *Bignonieæ*, capsule two-valved, two-celled, sometimes spuriously four-celled, with a dissepiment parallel or contrary to the valves, at length free, bearing the seeds, which are transverse, compressed, and winged.

Sub-order 2. *Cyrtandreæ* (Didymocarpeæ), fruit succulent or capsular, or siliquose and two-valved; seeds small, ovate, or cylindrical, suspended, apterous, sometimes comose.

Sub-order 3. *Crescentieæ*, fruit woody and melon-shaped, inclosing large seeds which are immersed in the pulp of the placentas.

Sub-order 4. *Pedalieæ*, fruit drupaceous, rarely capsular and two-valved, spuriously many-celled; seeds few, large, and apterous, pendulous, erect, or transverse. These are reckoned separate orders by many. There are upwards of one hundred known genera and about 650 species. Examples: Bignonia, Tecoma, Catalpa, Spathodea, Eccremocarpus, Cyrtandra, Didymocarpus, Crescentia, Pedalium, Sesamum, Martynia.

The Bignonia Family embraces many species of great beauty. The most conspicuous North American forms are Tecoma (T. radicans, or Trumpet Creeper) and Catalpa (C. bignonioides, Catalpa, or Catawba tree),

both well-known plants, the former a climber, conspicuous for its showy crimson flowers, the latter a tree with large heart-shaped leaves.

Jacaranda tomentosa, Mexico (*pl.* 63, *fig.* 9).

Bignonia leucoxylon, Antilles (*pl.* 63, *fig.* 10); *a*, the calyx; *b*, portion of the corolla tube laid open; *c*, pistil; *d*, side of the stigma.

ORDER 96. GENTIANACEÆ, the Gentian Family. Calyx gamosepalous, usually five-divided, sometimes four-, six-, eight-, or ten-divided, persistent. Corolla gamopetalous, hypogynous, usually regular and marcescent; limb sometimes fringed, divided into as many lobes as the calyx; æstivation plaited or imbricate-twisted. Stamens inserted upon the corolla, alternate with its segments, and equal to them in number, some of them occasionally abortive. Ovary composed of two carpels, unilocular, or partially bilocular; ovules 00, anatropal; style one, continuous; stigmas, one or two. Fruit, capsular or baccate, one-celled, usually bivalvular, with septicidal, or rarely loculicidal dehiscence. Seeds 00, small; embryo straight, minute, in the axis of soft, fleshy albumen; radicle next the hilum. Herbs, seldom shrubs, with opposite, rarely alternate, entire or divided, exstipulate leaves, which are often three- to five-ribbed. The plants of the order are distributed generally over the globe, inhabiting both cold and warm regions. They are rare in arctic and antarctic islands. They exhibit great varieties of colors, and many are highly prized for their beauty.

Sub-order 1. *Gentianeæ.* Lobes of the corolla, twisted to the right in the bud, with the folds at the sinuses, when present, plaited. Leaves almost always opposite or whorled, entire, those of the stem sessile. *Tribe* 1. *Chironieæ.* Anthers without connective, with the cells opening by a slit, abbreviated into a pore. Examples: Chironia, Lapithea, &c. *Tribe* 2. *Chloreæ.* A connective. Style distinct, caducous. Examples: Sabbatia, Erythræa, &c. *Tribe* 3. *Lisiantheæ.* A connective. Style persistent, distinct from the double or simple stigmata. Tropical plants, almost exclusively American. Examples: Pagœa, Prepusa, &c. *Tribe* 4. *Swertieæ.* A connective. Stigmata sessile or confluent with the persistent style. Plants inhabiting northern latitudes or the summits of mountains. Examples: Gentiana, Bartonia, Halenia, Frasera.

Sub-order 2. *Menyanthideæ.* Lobes of the corolla valvate in the bud, with the edges turned inwards. Stem-leaves alternate, petioled. Seed coat hard or bony. Plants growing in wet places. Examples: Menyanthes, Limnanthemum.

Sub-order 3. *Obolarieæ.* Lobes of the corolla imbricated in the bud. Leaves opposite, sessile. Ovules covering the whole inner surface of the ovary. Example: Obolaria.

Lindley assigns 60 genera and about 450 species to the order Gentianaceæ. Most of the genera indicated above have North American representatives.

Gentiana pneumonanthe, common gentian, Europe (*pl.* 63, *fig.* 11): *a*, calyx; *b*, corolla displayed; *c*, capsule; *d*, a seed magnified; *e*, seed.

ORDER 97. LOGANIACEÆ. Calyx, four- or five-leaved, with æstivation

imbricate or combined with valvate. Corolla hypogynous, with the limb four- or five-fid, the division similarly valvate or imbricated. Stamens inserted on the tube of the corolla, equal and alternate, or reduced to one. Anthers introrse, bilocular, opening longitudinally. Ovary free, of two cells, sometimes subdivided, each into two others, by the reflexion of their walls, each inclosing one or more ovules fixed at the internal angle, ascending, or more frequently peltate. Style simple, terminated by an undivided, or more rarely, bilobed stigma. Fruit fleshy or capsular, with septicidal dehiscence, rarely septifragal. Seeds often winged or peltate, presenting in the axis of a fleshy or cartilaginous perisperm, an embryo with plano-convex, or foliaceous cotyledons, the cylindrical radicle turned towards the hilum, or parallel to it. Species almost entirely tropical. Trees or shrubs, rarely herbs, distinguished from the Apocyaneæ by their watery juice, and the stipules which usually unite the petioles of the opposite and simple leaves. Flowers solitary in the axils of these leaves, or grouped in corymbs, in axillary or terminal panicles.

Sub-order 1. *Strychneæ.* Æstivation of corolla valvate; fruit, a two- or three-celled berry or capsule, seeds peltate, embryo rather large. Examples: Strychnos, Curare, &c.

Sub-order 2. *Loganieæ.* Æstivation of corolla convolute; fruit a bilocular capsule or nuculanium, seeds peltate, sometimes winged. Examples: Logania, Gelsemium.

Sub-order 3. *Spigelieæ.* Æstivation of corolla valvate; fruit a didymous capsule, seeds apterous, embryo small, cotyledons inconspicuous. Examples: Spigelia, Cœlostylis, Mitreola.

The plants of this order embrace the most virulent poisons known. One of these, Strychnos nux-vomica, a tree found on the coasts of Malabar and Coromandel, has for its seeds the deadly nux-vomica. The fruit is much like an orange, the seeds being embedded in a mucilaginous pulp. Two alkaloids are obtained from the nux-vomica, strychnine and brucine, occurring in combination with igasuric or strychnic acid. Strychnine is also found in other species of Strychnos. The poison, called *tieutè*, used by the Malays to envenom their daggers and creases, is obtained from Strychnos tieutè. The wourali, or ourari, with which the South American Indians poison their arrows, likewise owes its properties to strychnine. False angustura bark is obtained from the nux-vomica tree. Less than a grain of strychnine has been known to kill a dog. This poison is used to advantage in North America, for killing wolves and other wild animals, by spreading it on pieces of meat laid in accessible and frequented places. Spigelia marilandica, or Pink-root, is employed as a vermifuge.

Spigelia marilandica, Pink-root, United States (*pl.* 63, *fig.* 12).

ORDER 98. APOCYANACEÆ, the Dogbane Family. Calyx usually five-partite, persistent. Corolla hypogynous, gamopetalous, regular, usually five-lobed, deciduous; æstivation contorted, twisting in some cases to the right, in others to the left. Stamens five, inserted on the corolla, alternate with its segments; filaments distinct; anthers two-celled, dehiscing longitudinally; pollen granular, globose, or three-lobed, immediately applied

to the stigma. Ovaries two, and each unilocular, or one and bilocular; ovules 00; styles two or one; stigma one, with a contraction in the middle. Fruit follicular or capsular, or drupaceous or baccate, double or single. Seeds 00, rarely definite, usually pendulous; albumen cartilaginous, or fleshy, rarely 0; embryo foliaceous; radicle turned towards the hilum. Trees or shrubs, usually lactescent, with entire, generally opposite, exstipulate leaves, with interpetiolary cilia or glands. They are chiefly found in tropical regions. Lindley enumerates 100 genera, including 566 species.

Sub-order 1. *Carisseæ.* Ovary single, bilocular, or unilocular, with placentas parietal and corresponding to the suture of the carpels. Fruit baccate, very rarely capsular. Example: Carissa.

Sub-order 2. *Ophioxyleæ.* Ovary double, fruit drupaceous. Examples: Ophioxylon, Cerbera.

Sub-order 3. *Euapocyaneæ.* Ovary double. Fruit follicular; follicles often fleshy or pulpy. *Tribe* 1. *Plumerieæ.* Seeds without hairs, often peltate. Examples: Hunteria, Tabernæmontana, &c. *Tribe* 2. *Alstonieæ.* Follicles coriaceous; seeds peltate, ciliate; ciliæ elongated, forming a kind of coma at the two ends of the seeds. Example: Alstonia. *Tribe* 3. *Echiteæ.* Follicles coriaceous or membranous, distinct or rarely united so as to constitute a single capsule. Seeds comatose towards the hilum or point of attachment. Examples: Apocynum, Nerium.

Sub-order 4. *Wrightieæ.* Seeds comatose at the apex. Example: Wrightia.

The sole representative of this order in the northern part of North America is the genus Apocynum or dogbane, supposed to be poisonous to dogs. Many plants of the order are poisonous, although a few yield edible fruits. The Tanghin poison of Madagascar is obtained from the seeds of Tanginia venenata. Even the common Oleander (Nerium) is poisonous. Species of Urceola and Vahea supply caoutchouc. The juice of Tabernæmontana utilis, the Cow tree of Demerara, is used as milk.

Nerium oleander, Oleander (Europe and Asia) (*pl.* 63, *fig.* 13); *a*, anther; *b*, pistil; *c*, a seed.

Order 99. Asclepiadaceæ, the Milkweed Family. Calyx five-divided, persistent. Corolla synpetalous (monopetalous), hypogynous, regular, five-lobed, deciduous; æstivation imbricate, rarely valvate. Stamens five, inserted into the base of the corolla, and alternate with its segments; filaments usually combined so as to form a tube; staminal tube rarely naked behind, generally furnished with a corona (crown) of variously-formed leaves, which are either distinct or connate. Anthers bilocular, each cell sometimes spuriously divided; pollen, when the anther dehisces, cohering in masses (pollinia), which are either as numerous as the cells, or are confluent in pairs, and adhere to the five stigmatic processes, either in sets of two or four, or singly. Ovaries two; ovules 00; styles two, closely approaching each other, often very short; stigma common in both styles, dilated, quinquangular; the angles furnished with cartilaginous corpuscles which retain the pollinia, or with glands. Fruit consisting of two follicles

(sometimes only one by abortion), having a placenta on the ventral suture. Seeds 00, imbricate, pendulous, usually comose (hairy) at the hilum; albumen thin; embryo straight; cotyledons leafy; radicle superior. Shrubs, or occasionally herbs, usually with milky juice, and often twining. The leaves are usually opposite, sometimes alternate or verticillate, with interpetiolary cilia in place of stipules. The gynostegium, staminal crown or peculiar hooded (cucullate) appendages, prolonged from the tube of the filaments, which occur in many of the plants of this order, give a peculiar aspect to their flowers. They inhabit chiefly warm and tropical regions, but many species extend to northern climates. Many succulent species are found in the south of Africa. Lindley enumerates 141 genera, including 910 species.

Tribe 1. *Ceropegieæ.* Pollinia upright. Examples: Ceropegia, Hoya, Stapelia. *Tribe* 2. *Gonolobeæ.* Pollinia horizontal. Example: Gonolobus. *Tribe* 3. *Oxypetaleæ.* Pollinia pendent, supported by winged processes, with a lateral spur. Example: Calostigma. *Tribe* 4. *Asclepieæ.* Pollinia pendent. Examples: Asclepias, Acerates, Enslenia. *Tribe* 5. *Periploceæ.* Pollinia granular. Granules four-lobed. Example: Periploca. *Tribe* 6. *Secamoneæ.* Anthers four-locular, pollinia twenty, applied by fours to the summit of the corpuscles. Example: Secamone.

The milky juice with which plants of this order abound, is usually bitter and acrid, sometimes mild, as in the Cow plant of Ceylon, Gymnema lactiferum. The wax plant of greenhouses (Hoya carnosa) derives its name from the peculiar appearance of the flowers. The stapelias are remarkable for the odor of the blossoms, which resembles that of rotten flesh. Flesh flies, it is said, are deceived to such an extent by the smell, as to deposit their eggs on the plant. The most conspicuous species of the United States is Asclepias cornuti (A. syriaca) known as silk or milk weed, a plant of some economical value. In certain districts of Europe, as in Silesia, it is cultivated on a large scale. The stem is rotted like hemp, and yields a strong fibre; the long silky hairs attached to the seeds are spun into various fabrics with silk or cotton, or else used in pillows as a substitute for down. Sugar has been extracted from the flowers, and the juice contains an abundance of caoutchouc. The hairs of the seeds, when properly prepared, afford an excellent gun-cotton, much superior to that from true cotton.

Cynanchum vincetoxicum (Europe) (*pl.* 64, *fig.* 1); *a*, flower branch; *b*, natural size of the flower; *c*, process of the stigma; *d*, section of the ovary; *e*, pollen mass; *f*, pistil; *g*, seed vessels; *h*, seed; *i*, vertical section of do.

Asclepias cornuti (A. syriaca), Milkweed (United States) (*pl.* 64, *fig.* 2); *a*, group of flowers; *b*, corona; *c*, the calyx; *d*, stamina; *e*, segments of corona exhibiting some of the pollinia; *f*, two attached pollen masses magnified; *g*, section of the seed vessel; *h*, a seed; *i*, vertical section of do.

Order 100. Oleaceæ, the Olive Family. Flowers ☿, sometimes ♂ ♀. Calyx gamosepalous, divided, persistent. Corolla gamopetalous, hypogynous, four-cleft, sometimes of four petals which are connected in pairs by means

of the filaments, sometimes 0; æstivation somewhat valvate. Stamens two (rarely four), alternate with the corolline segments; anthers dithecal, with longitudinal dehiscence. Disk 0. Ovary free, two-celled; ovules in pairs, collateral or pendulous; style one, or 0; stigma entire or bifid. Fruit drupaceous, baccate or capsular, sometimes samaroid. Seeds often by abortion solitary; albumen dense, fleshy, abundant; embryo straight, about half the length of the albumen; cotyledons leafy; radicle superior. Trees or shrubs, with opposite leaves, which are either simple or compound. Found chiefly in temperate regions. They occur in North America, Asia, Europe, and New Holland. There are two sections of the order: 1. *Oleæ*, with a drupaceous or berried fruit. 2. *Fraxineæ*, with a samaroid (winged) fruit. Lindley mentions twenty-four genera, including 130 species. Examples: Olea, Ligustrum, Chionanthus, Fraxinus, Syringa.

The most important plant of this order is the olive, Olea europæa, whose fruit yields olive oil by expression. The best oil comes from Provence and Florence. Castile soap is made from olive oil and soda. Potash and oil make a soft soap. A species (Olea americana) indigenous in the southern United States, is called devilwood. The so-called flowers of tea are, in part, the blossoms of Olea fragrans, a Chinese species. The Lilac, Syringa vulgaris, and the Privet, Ligustrum vulgare, belong to this order, and are both naturalized in some parts of the United States. Chionanthus or the Fringe tree is a very ornamental American species. The timber of Fraxinus or the ash, is highly valuable.

Olea europæa, the Olive (Europe) (*pl.* 62, *fig.* 3); *a*, a flower branch reduced; *b*, a flower; *c*, pistil; *d*, vertical section of do.; *e*, do. of fruit; *f* and *g*, sections of the nut; *h*, embryo.

Order 101. Jasminaceæ, the Jessamine Family. Flowers ☿, calyx five- to eight-divided or toothed, persistent. Corolla monopetalous, hypogynous, regular, salver-shaped, five- to eight-divided; æstivation twisted or valvate. Stamens two, inserted on the corolla, included; anthers bilocular, with longitudinal dehiscence. Disk 0. Ovary free, two-celled; ovules erect, anatropal, one to four in each cell; style one; stigma two-lobed. Fruit a double berry, or a pyxidium, or a two-valved capsule. Seeds usually solitary, rarely in pairs, albuminous or exalbuminous; embryo straight; radicle inferior. Shrubs, often with twining stems, and opposite or alternate, pinnate leaves. They abound chiefly in the tropical parts of India. They have frequently fragrant flowers which yield oils, and their leaves and roots are sometimes bitter. There are five genera and one hundred species. Examples: Jasminum, Nyctanthes, Bolivaria. Species of Jessamine (Jasminum) have become naturalized in the Southern States.

Jasminum officinale (Southern Asia) (*pl.* 62, *fig.* 4); *a*, calyx; *b*, corolla displayed.

Order 102. Myrsinaceæ, the Myrsine Family. Flowers hermaphrodite or occasionally unisexual. Calyx four- to five-cleft, persistent. Corolla monopetalous, hypogynous, four- to five-cleft, equal. Stamens four to five, inserted into the corolla, and opposite to its segments; filaments distinct, rarely united, sometimes 0, occasionally five sterile petaloid alternating

ones; anthers sagittate, erect, bilocular, with longitudinal dehiscence. Ovary free or slightly adherent, unilocular; ovules definite or indefinite, campylotropal, immersed in a free central placenta; style single; stigma simple or lobed. Fruit fleshy, one- or many-seeded. Seeds angular or roundish, with a concave hilum, and a membranous spermoderm; albumen horny; embryo usually curved, often heterotropal; cotyledons short; radicle horizontal when the seed is solitary, inferior when there are several seeds. Trees, shrubs, or undershrubs, with alternate or opposite, coriaceous, exstipulate leaves. They are much restricted as regards their geographical limits, and they are said to abound chiefly in islands with an equable temperature. They are found in Africa, Asia, and America. Little is known regarding their properties. Theophrasta jussiæi is a prickly-leaved shrub, which is called Coco in St. Domingo. Its seeds are eatable, and a kind of bread is made from them. The Ardisias are prized for the beauty of their foliage. There are thirty-one known genera, and 325 species. Examples: Myrsine, Ardisia, Mæsa, Jacquinia.

Order 103. Sapotaceæ, the Sapodilla Family. Flowers hermaphrodite. Calyx regular, with five, sometimes four to eight divisions, persistent; æstivation valvate or imbricate. Corolla monopetalous, hypogynous, deciduous, regular, its lobes equal to, rarely twice or thrice as many as, those of the calyx. Stamens inserted on the corolla, definite, distinct; fertile ones as many as, rarely more than, the segments of the calyx, with which they alternate; sterile ones alternating with the fertile ones, rarely wanting. Disk 0. Ovary free, plurilocular; ovules solitary, anatropal, ascending or pendulous; style one; stigma simple, sometimes lobed. Fruit fleshy, plurilocular, or by abortion unilocular. Seeds nut-like, solitary; testa bony and shining, with a long scar on its inner face; embryo large, erect, white; albumen usually fleshy; sometimes 0; cotyledons in the albuminous seeds, foliaceous, in the exalbuminous, fleshy; radicle straight or slightly curved, pointing to the hilum. Lactescent trees or shrubs, with alternate, exstipulate, entire, coriaceous leaves. They are natives chiefly of the tropical parts of India, Africa, and America. The number of known genera noticed by Lindley is twenty-one, species 212. Examples: Isonandra, Achras, &c.

Some species of this family furnish fruit of great excellence, as the Sappodilla plum, and naseberry in the West Indies from species of Achras. Shea butter is probably derived from Bassia parkii. The most important product is Gutta Percha, the concrete juice of Isonandra gutta and perhaps of other species, found in Singapore, Borneo, and Malacca. This substance is rapidly coming into use for a vast variety of purposes, being very tough, softening readily by the heat of boiling water, and sufficiently elastic at ordinary temperatures without being extensible like caoutchouc.

Mimusops dissecta (Manilla) (*pl.* 64, *fig.* 3); *a*, flower branch with the leaves removed; *b*, flower opened; *c*, anther; *d*, a fruit branch; *e*, a seed.

Order 104. Aquifoliaceæ or Ilicineæ, the Holly Family. Sepals four to six; æstivation imbricated. Corolla monopetalous, hypogynous, four to six-parted; æstivation imbricate. Stamens inserted into the corolla,

alternate with its segments, and equal to them in number ; filaments straight ; anthers adnate, bilocular, introrse. Disk 0. Ovary free, fleshy, somewhat truncate, two- to six-celled ; ovules solitary, anatropal, pendulous from a cup-shaped funiculus ; stigma nearly sessile, lobed. Fruit fleshy, indehiscent, with two to six monospermous nucules, and hence it is sometimes called a nuculanium. Seed suspended ; albumen large, fleshy ; emoryo small, lying next the hilum ; cotyledons small ; radicle superior. Evergreen trees or shrubs, with alternate or opposite, coriaceous, simple, exstipulate leaves. They are found in various parts of the world, as in Europe, North and South America, and Africa. Lindley enumerates eleven genera, including 110 species. Examples : Ilex, Prinos, Nemopanthes.

All the above-mentioned genera are North American. The American Holly, Ilex opaca, has less glossy leaves and less brilliant berries than the European, I. aquifolium. The leaves of Ilex paraguayensis constitute the Yerba maté or Paraguay tea.

Ilex aquifolium, European Holly (*pl.* 71, *fig.* 6) ; *a–g*.

Order 105. Ebenaceæ, the Ebony Family. Flowers hermaphrodite or unisexual. Calyx three- to seven-divided, nearly equal, persistent. Corolla gamopetalous, regular, deciduous ; somewhat coriaceous ; limb three- to seven-divided ; æstivation imbricated. Stamens either attached to the corolla or hypogynous, two or four times as many as the corolline segments, rarely equal to them in number, and then alternate with them ; filaments usually in two rows, the inner row having smaller anthers ; anthers erect, lanceolate, bilocular, with longitudinal dehiscence. Ovary free, sessile, plurilocular ; ovules one to two in each cell, pendulous ; style divided, rarely simple ; stigmas bifid or simple. Fruit fleshy, round or oval, the pericarp sometimes opening regularly. Seeds few ; testa membranous ; embryo straight, nearly in the axis of cartilaginous albumen ; cotyledons leafy ; radicle taper, next the hilum. Trees or shrubs, not lactescent, with alternate, exstipulate, coriaceous leaves. They are chiefly found in tropical regions, and many species are met with in India. The plants are in general remarkable for the hardness and durability of their wood. Some yield edible fruit. Diospyros ebenus, and other African and Asiatic species, supply Ebony, which is the black duramen of the tree. Other species of Diospyros furnish Ironwood. Diospyros virginiana, the Persimmon, yields a fruit which is astringent when green, but becomes sweet and eatable when ripe, especially after being acted on by frost. D. kahi is the Keg-fig of Japan, the fruit of which resembles a plum. Lindley notices nine genera, including 160 species. Examples : Diospyros, Royena, Maba.

Order 106. Styracaceæ, the Storax Family. Calyx persistent, with an entire or a five- or four-divided limb. Corolla gamopetalous, regular, inserted in the calyx ; æstivation imbricated or valvate. Stamens definite or 00, attached to the corolline tube, of unequal length ; filaments often slightly united at their base in one or more parcels ; anthers innate, dithecal, introrse. Ovary either free or cohering more or less to the calycine tube, two- to five-celled, the septa occasionally deficient towards the centre ; ovules, two to four in each cell, or 00, pendulous, sometimes the upper ones

ascending; style simple; stigma simple. Fruit inclosed in the calyx, drupaceous, usually unilocular by abortion. Seeds usually solitary, erect, or suspended; embryo slender, in the axis of fleshy albumen; cotyledons flat, foliaceous; radicle long, pointing to the hilum. Trees or shrubs, with alternate, exstipulate leaves, and frequently stellate hairs. They are chiefly natives of warm countries. There are two sections: 1. *Styraceæ*, with a more or less valvate æstivation of the corolla, and long anthers. 2. *Symploceæ*, with a quincuncial corolline æstivation, and roundish anthers. Lindley gives 6 genera, including 115 species. Examples: Styrax, Halesia, Symplocos.

Storax, a well-known balsamic, resinous substance, is the concrete juice of Styrax officinale, a native of the Mediterranean region. Styrax benzoin, a tree growing in Sumatra and Borneo, furnishes gum benzoin. North American representatives are species of Halesia or Snow-drop tree, found in the southern States.

Styrax benzoin (*pl.* 64, *fig.* 4); *a*, a flowering branch; *b*, a flower; *c*, ditto exposed; *d*, anthers; *e*, the pistil; *f*, section of ovary; *g*, fruit; *h*, portion of the pericarp removed, showing the stone; *i*, the stone with the upper portion removed; *k*, section of seed.

Order 107. Columelliaceæ, the Columellia Family. Calyx superior, quinquepartite. Corolla rotate, inserted into the calyx, five- to eight-parted; æstivation imbricate. Stamens two, inserted in the throat of the corolla; anthers roundish, three-lobed, extrorse, each consisting of six linear, sinuous cells, arranged in pairs, dehiscing longitudinally, and attached to a three-lobed, fleshy connective. Disk fleshy, perigynous. Ovary adhering to the calycine tube, two-celled; ovules 00; style simple, smooth; stigma capitate, two-lobed. Fruit, a bilocular, bivalvular capsule, with both septicidal and loculicidal dehiscence. Seeds 00; testa smooth and coriaceous; embryo straight, in the axis of fleshy albumen; cotyledons oval, obtuse; radicle long, pointing to the hilum. Evergreen shrubs or trees, with opposite, entire, exstipulate leaves, and solitary yellow flowers. Natives of Mexico and Peru. Their properties unknown. There is one genus mentioned, including three species. Example: Columellia.

Order 108. Epacridaceæ, the Epacris Family. Calyx five-, rarely four-parted, often colored, persistent. Corolla inserted at the base of the calyx, or hypogynous, deciduous or marcescent, monopetalous, sometimes separable into five petals; limb with five, rarely four equal divisions, sometimes by the cohesion of the segments bursting transversely; æstivation imbricated or valvate. Stamens inserted with or on the corolla, equal in number to, and alternate with its segments, rarely fewer; anthers one-celled, without appendages, opening longitudinally; pollen round, or formed of three united grains, attached to a single central receptacle. Ovary sessile, free, plurilocular, rarely unilocular, surrounded by scales at the base; ovules solitary or 00; style one; stigma simple, sometimes toothed. Fruit drupaceous, baccate, or capsular. Seeds albuminous; embryo slender, in the axis of fleshy albumen, and about half its length. Shrubs or small trees, with alternate, rarely opposite, exstipulate leaves, which are sometimes half-

amplexicaul at the base. They are allied to Ericaceæ, and seem to occupy the place of heaths in Australia. They are distinguished from heaths by the structure of their anthers. They are cultivated for the beauty of their flowers. In some cases they yield edible fruits. One of the plants called Native Currant in Australia is Leucopogon richei. The order has been divided into two sections: 1. *Epacreæ*, polyspermous. 2. *Stypheliew*, monospermous. There are 30 known genera and 320 species, according to Lindley. Examples: Epacris, Sprengelia, Styphelia, Leucopogon, Lissanthe.

ORDER 109. VACCINIACEÆ, the Cranberry Family. Calyx superior, entire, four- to six-lobed. Corolla monopetalous, four- to six-lobed; æstivation imbricated. Stamens distinct, eight to twelve, inserted into an epigynous disk; anthers bilocular, with two horn-like cells, dehiscing by pores. Ovary inferior, four- or five-celled; ovules 00; style simple; stigma simple. Fruit succulent, crowned by the persistent limb of the calyx. Seeds one or many in each cell, minute; embryo straight, in the axis of fleshy albumen; cotyledons very short; radicle long, inferior. Shrubby plants, with alternate, undivided, exstipulate leaves. They are closely allied to Ericaceæ, and differ from that order chiefly in their adherent (inferior) ovary. They are natives of temperate regions, and some of them are marsh plants. Some are astringent, others yield sub-acid edible fruits. Cranberries are produced by Vaccinium oxycoccus (Oxycoccus palustris of some authors) and V. macrocarpum. Examples: Vaccinium, Gaylussaccia, Chiogenes. The American Huckleberries, Bilberries, Deerberries, &c., are furnished by various species of Vaccinium, and of Gaylussaccia.

ORDER 110. ERICACEÆ, the Heath Family. Calyx, four- or five-cleft, nearly equal, persistent. Corolla inserted at the base of the calyx, or hypogynous, monopetalous, four- or five-cleft, sometimes tetra- or pentapetalous, regular or irregular, often marcescent; æstivation imbricated. Stamens definite, equal in number to the segments of the corolla, or twice as many, inserted with the corolla, and either free from it or attached to its base; anthers two-celled; cells hard and dry, bifid, usually having appendages at the base or apex, dehiscing by apicilar pores or clefts. Ovary free, surrounded at the base by a disk or scales, plurilocular; ovules 00, attached to a central placenta; style one, straight; stigma one, undivided or toothed. Fruit capsular or baccate, many-celled, with loculicidal or septicidal dehiscence. Seeds 00, minute; embryo cylindrical, in the axis of fleshy albumen; radicle next the hilum. Shrubs, undershrubs, or herbaceous plants, with evergreen, often rigid, entire, verticillate, or opposite, exstipulate leaves. The order contains many beautiful and showy plants, which abound at the Cape of Good Hope, and which are also found in Europe, North and South America, and Asia. The order has been divided into the following sub-orders:

Sub-order 1. *Ericineæ.* Calyx free from the ovary. Corolla monopetalous, or rarely nearly or entirely polypetalous. Seed-coat close and thin, rarely loose and cellular. *Tribe* 1. *Salaxideæ.* Corolla persistent; cells one-ovuled; anthers unarmed; buds naked. Example: Salaxis. *Tribe* 2.

Ericeæ. Cells many-seeded. Examples: Erica, Calluna. *Tribe* 3. *Arbuteæ.* Fruit, a berry or drupe. Examples: Arbutus, Arctostaphylos. *Tribe* 4. *Andromedeæ.* Fruit, a pod, opening loculicidally. Examples: Gautiera, Epigæa, Andromeda, Clethra. *Tribe* 5. *Rhodoreæ.* Fruit, a pod, opening septicidally. Examples: Rhodora, Azalea, Rhododendron, Kalmia, Loiseleuria, Ledum, Leiophyllum.

Sub-order 2. *Pyroleæ.* Calyx free from the ovary; petals distinct, or nearly so; seeds with a very loose and cellular covering, much larger than the nucleus; mostly herbaceous, with evergreen foliage. Examples: Pyrola, Chimaphila, Moneses.

Sub-order 3. *Monotropeæ.* Flowers nearly as in sub-orders one and two, seeds as in three. Entirely destitute of green foliage, with the aspect of Beech drops. Examples: Pterospora, Hypopitys, Monotropa.

The entire order includes about 52 genera and 880 species, many of which are North American. The true heaths are, however, entirely wanting in this continent. The heather of England is composed of Calluna vulgaris. The Rhododendrons, Azaleas, and Kalmias, of North America, are among her most showy plants. Kalmia latifolia, or common Laurel, is said to be poisonous to sheep, but not to deer and pheasants (Tetrao umbellus). Well authenticated cases exist of poisonous effects produced by eating these birds after they had devoured Laurel-buds. Gautiera procumbens, Tea-berry, or Wintergreen, is used to flavor candies and syrups. Chimaphila umbellata, or Pipsissiwa, has medicinal properties. Monotropa uniflora, or Indian pipe, is a singular plant, entirely white and fleshy, found in damp, rich woods.

Erica filamentosa, Cape Heath, Cape of Good Hope (*pl.* 64, *fig.* 6); *a,* a flowering branch; *b,* anther magnified; *c,* pistil magnified.

Ledum palustre, Marsh Tea, Northern Europe and America (*pl.* 64, *fig.* 5); *a,* a flowering branch; *b,* portion of lower surface of leaf magnified; *c,* calyx and sexual apparatus; *d,* stamen magnified; *e,* the stigma; *f,* open capsule magnified; *g,* cross-section of ditto; *h,* seeds on the placenta; *i,* a seed magnified.

ORDER 111. GESNERACEÆ, the Gesnera Family. Calyx partially adherent, five-partite; æstivation valvate. Corolla monopetalous, tubular, more or less irregular, five-lobed; æstivation imbricated. Stamens four, didynamous, with the rudiment of a fifth, rarely two; anthers dithecal, with a thick swollen connective. Ovary partly free, unilocular, formed by two carpels with parietal placentas, which are two-lobed; ovules indefinite, anatropal; style continuous with the ovary; stigma capitate, concave, glandular or annular. Disk surrounding the base of the ovary. Fruit capsulate or succulent, one-celled, more or less adherent. Seeds 00, minute; testa thin, finely and obliquely veined; embryo erect in the axis of fleshy albumen; radicle pointing to the hilum. Herbs or shrubs, often springing from scaly tubers, with opposite or whorled, rugose, exstipulate leaves, and showy flowers. They are found principally in the warmer regions of America, and are interesting chiefly on account of their beauty, for they do not appear to possess any important qualities. There are twenty-two known genera

and upwards of 120 species. Examples: Gesnera, Columnea, Gloxinia, Achimenes.

Order 112. Lobeliaceæ, the Lobelia Family. Calyx superior, five-lobed or entire. Corolla gamopetalous, inserted on the calyx, irregular, more or less deeply five-cleft. Stamens five, attached to the calyx, alternate with the segments of the corolla; anthers cohering; pollen oval. Ovary inferior, one- to three-celled; ovules 00, attached either to central or parietal placentæ; style glabrous, with a fringe of hairs below the stigma. Fruit a one- or more-celled capsule, with apicilar dehiscence. Seeds numerous; embryo straight, in the axis of fleshy albumen; radicle pointing to the hilum. Lactescent herbs or shrubs, with alternate, exstipulate leaves. They are found both in temperate and warm countries. There are twenty-seven known genera and 375 species. Examples: Lobelia, Siphocampylus, Clintonia.

Acridity characterizes the order to a greater or less extent. Lobelia inflata, or Indian tobacco, is a remedy in great favor with a certain class of practitioners. Other species also, as L. siphilitica, are considered efficacious in some diseases.

Lobelia fulgens (Mexico) (*pl.* 64, *fig.* 8); *a*, upper part of the plant; *b*, stamens expanded and magnified; *c*, stamens with the anthers cut across; *d*, stamens and pistil; *e*, stigma.

Order 112. Campanulaceæ, the Hare-bell Family. Calyx superior, usually five-lobed, sometimes three- to eight-lobed, persistent. Corolla gamopetalous, inserted into the top of the calyx, usually five-lobed, sometimes three- to eight-lobed, regular, marcescent; æstivation valvate. Stamens inserted into the calyx, alternating with the corolline lobes, and equal to them in number; anthers bilocular, free; pollen spherical. Ovary more or less completely inferior, composed of two or more carpels; ovules indefinite; style simple, covered with collecting hairs; stigma naked, simple, or with as many lobes as there are ovarian cells. Fruit capsular, crowned with the withered calyx and corolla, dehiscing in a loculicidal manner by lateral apertures, or by valves at the apex. Seeds 00; attached to a central placenta; embryo straight, in the axis of fleshy albumen; radicle pointing to the hilum. Lactescent herbs or undershrubs, with alternate, rarely opposite, exstipulate leaves. The hairs on the style are said to be retractile, and seem to be connected with the application of the pollen. The flowers in most instances are blue. They are natives chiefly of northern and temperate regions. They abound in the alpine regions of Europe and Asia, and are also frequent in North America. Alphonse De Candolle states, that the species whose capsule dehisces by lateral fissures are natives of the northern hemisphere, while those with apicilar dehiscence are principally found in the southern hemisphere. The milky juice found in the plants of this order has acrid properties. Lindley enumerates twenty-eight genera, including five hundred species. Examples: Campanula, Phyteuma, Jasione.

Campanula trachelium, Hare-bell (Europe) (*pl.* 64, *fig.* 7); *a*, upper portion of the plant; *b*, sexual apparatus; *c*, separated stamens; *d*, stamen;

e, a seed-vessel; *f*, cross-section of do.; *g*, the seed; *h*, do. magnified; *i*, section of do.

ORDER 113. STYLIDIACEÆ, the Stylewort Family. Calyx adherent, persistent, with two to six divisions, bilabiate, or regular. Corolla gamopetalous, falling off late, limb usually irregular, five- to six-partite, segments with a central vein; æstivation imbricated. Stamens two; filaments united with the style into a longitudinal column; anthers didymous, rarely simple, lying over the stigma; pollen simple, globose, or angular. Ovary cohering with the calyx, bilocular, or by contraction of the dissepiment unilocular, often surmounted by one gland in front, or by two opposite ones; ovules anatropal; style one; stigma entire or bifid. Fruit a bivalvular, bilocular, or spuriously unilocular capsule, with septicidal dehiscence. Seeds 00, small, erect; embryo minute, inclosed in fleshy, somewhat oily albumen. Non-lactescent herbs or undershrubs, with alternate, scattered, or somewhat verticillate, entire, exstipulate leaves. They are well distinguished by their gynandrous structure. The column formed by the union of the filaments and style possesses, in the species of the genus Stylidium, a peculiar irritability. The plants are principally natives of marshy places in New Holland. Some are found at the southern point of South America. There are five known genera, and 121 species. Examples: Stylidium, Forstera.

ORDER 114. GOODENIACEÆ, the Goodenia Family. Calyx persistent, usually equal, with three to five divisions, sometimes obsolete. Corolla inserted into the calyx, monopetalous, more or less irregular, marcescent or deciduous; its tube split at the back, and sometimes separable into five pieces, when the calyx only coheres with the base of the ovary; its limb five-partite, uni- or bilabiate, the thin part of the segments being at the edges, which are folded inwards in æstivation. Stamens five, distinct, inserted with, but free from, the corolla, and alternate with its segments; anthers not articulated with the filaments, distinct or cohering, bilocular, with longitudinal dehiscence; pollen grains either separate or united in fours. Ovary more or less united to the calycine tube, one-, two-, or four-celled, sometimes with a gland at its base; ovules definite or 00, attached to a central, often free, placenta; style one, simple, rarely divided; stigma fleshy, undivided or two-lobed, surrounded by a cup-like indusium. Fruit a one-, two-, or four-celled capsule, or drupaceous or nut-like. Seeds definite or indefinite, with a thickened, often hard testa; embryo straight, in fleshy albumen; cotyledons leafy; radicle inferior. Herbs, rarely shrubs, not lactescent, with scattered, exstipulate, usually alternate leaves, and distinct, never capitate flowers. They are found chiefly in Australia, and in the South Sea Islands. The order is divided into two sub-orders.

Sub-order 1. *Goodenieæ*, with dehiscent capsular fruit, and numerous seeds.

Sub-order 2. *Scævoleæ*, with indehiscent, drupaceous, or nut-like fruit, and seeds solitary, or two in each cell. There are fourteen known genera, according to Lindley, and about 150 species. Examples: Goodenia, Velleia, Leschenaultia, Scævola, Dampiera.

ORDER 115. BRUNONIACEÆ, the Brunonia Family. Calyx persistent, five-

partite, with bracts at the base. Corolla inserted at the base of the calyx, monopetalous, nearly regular, withering; limb five-parted, having central veins in its segments, which divide at the top into two recurrent marginal veins; æstivation valvate. Stamens five, inserted with, but free from, the corolla, alternating with its segments; anthers articulated with the short filaments, dithecal, introrse, dehiscing longitudinally. Ovary free, unilocular; ovule solitary, erect, anatropal; style single; stigma inclosed in a two-valved cup or indusium. Fruit a utricle, inclosed in the hardened calycine tube. Seed solitary, erect, exalbuminous; embryo straight; cotyledons fleshy; plano-convex; radicle minute, inferior. Stemless herbaceous plants, with radical, exstipulate leaves, and capitate flowers, supported on scapes, and surrounded by an involucre of enlarged bracts. Natives of New Holland. Their properties are unknown. The order contains as yet only one genus and nine species. Example: Brunonia.

Order 116. Compositæ, Syngenesia of Linn. Flowers collected into a dense head (compound flowers of the older authors) upon a common receptacle, surrounded by an involucre. Tube of the calyx coherent with the ovary, and undistinguishable from it; the limb (called *pappus*) composed of bristles, or scales, &c., or very rarely foliaceous, often wanting or reduced to a margin. Corolla composed of mostly five united petals; either ligulate or tubular, in the latter case with a valvate æstivation; the tube generally furnished with five nerves (or more properly ten united in pairs), which extend from the base to the sinuses, where they divide, a branch coursing along or near each margin to the apex of the lobes. Stamens as many as the lobes of the corolla and alternate with them: the filaments (distinct or united above) inserted into the tube; anthers linear, coherent by their margins into a cylinder (*syngenesious*). Ovary one-celled, containing a single erect anatropous ovule; style (usually undivided in the sterile flowers) two-cleft; the lobes or branches (incorrectly called stigmas) various in form, mostly flattish within, often furnished with collecting hairs; the proper stigmas occupying their inner margins, in the form of glandular, slightly prominent lines. Fruit an indehiscent, dry, one-seeded pericarp (achænium), crowned with the limb of the calyx or pappus. Seed destitute of albumen. Radicle short; cotyledons flat or plano-convex. Herbs, rarely shrubs or trees (forming about one tenth of phanerogamous vegetation); with alternate or opposite, sometimes divided or lobed, exstipulate leaves. Branches often corymbose, terminated by the heads, the central ones earliest developed. Flowers in each head expanding successively from the margin (or lower portion) to the centre or apex, either all of the same color (*homochromous*), or the marginal ones different from those of the disk (*heterochromous*), the latter in this case almost always yellow; either perfect, polygamous, or diclinous.

This order is both one of the largest and one of the most natural in the vegetable kingdom. The plants are generally distributed over the surface of the globe, and all of the tribes have North American representatives. Generally herbaceous in northern regions, they become at times shrubby and even arborescent in warm climates. The number of known genera

amounts to upwards of 1000, including 9500 species, and forming about one tenth of all the known species. Various subdivisions have been proposed by different authors; those by Linnæus into Polygamia æqualis, superflua, frustranea, necessaria, and segregata, will be found explained on page 54. The sub-orders more usually followed by modern authors are those of De Candolle, as follows: 1. *Tubulifloræ.* Corolla of the perfect flowers tubular, and regularly five- (rarely three- to four-) lobed or toothed. 2. *Labiatifloræ.* Corolla of the perfect flower bilabiate. 3. *Liguliflorae.* Flowers all perfect and ligulate. (The genera marked with an asterisk are North American.)

SUB-ORDER 1. TUBULIFLORÆ.

Tribe 1. *Vernoniaceæ.* Style of the perfect flowers cylindraceous; the branches usually elongated and subulate, hispid throughout; the stigmatic lines not extending beyond their middle.

Sub-tribe 1. *Vernonieæ.* Heads discoid, homogamous. *Division* 1. *Euvernonieæ.* *a,* Ethulieæ. Example: Ethulia. *b,* Heterocomeæ. Examples: *Stokesia, *Vernonia. *c,* Albertinieæ. Example: Albertinia. *Division* 2. **Elephantopeæ.* Example: Elephantopus. *Division* 3. *Rolandreæ.* Example: Gundelia. *Division* 4. *Bojerieæ.* Example: Synchodendron.

Sub-tribe 2. *Pectideæ.* Heads radiate, heterogamous. *Division* 1. *Liabeæ.* Example: *Xanthisma. *Division* 2. *Eupectideæ.* Examples: *Pectis, Pectidopsis.

Tribe 2. *Eupatoriaceæ.* Style of the perfect flowers cylindraceous: the branches elongated, obtuse, or clavate, externally puberulent or papillose towards the summit, the stigmatic lines obscure, terminating near their middle.

Sub-tribe 1. *Eupatorieæ.* Heads discoid, homogamous. *Division* 1. *Alomieæ.* Ex.: Orsinia. *Division* 2. *Agerateæ.* Ex.: *Cœlestina, *Ageratum, *Sclerolepsis. *Division* 3. *Adenostyleæ.* Ex.: *Liatris, *Kunia, *Eupatorium.

Sub-tribe 2. *Tussilagineæ.* Heads with the flowers heterogamous or diœcious. *Division* 1. *Petasiteæ.* Examples: *Nardosmia, *Adenocaulon. *Division* 2. *Eutussilagineæ.* Example: *Tussilago.

Tribe 3. *Asteroideæ.* Style of the perfect flowers cylindraceous: the branches linear, externally flattish, minutely and equally pubescent above, stigmatic lines prominent, extending about to the origin of the exterior pubescence.

Sub-tribe 1. *Asterineæ.* Heads heterogamous and radiate, or homogamous. Receptacle seldom chaffy. Anthers not caudate. Leaves alternate. *Division* 1. *Amellieæ.* *a,* Euamelleæ. Example: Amellus. *b,* Heterothalameæ. Example: Heterothalamus. *Division* 2. *Astereæ.* *a,* Euastereæ. Examples: *Galatella, *Aster. *b,* Diplopappeæ. Example: *Diplopappus. *c,* Erigereæ. Example: *Erigeron. *d,* Heteropappeæ. Examples: *Chætopappa, *Boltonia. *e,* Bellieæ. Example: Bellium. *f,* Bellideæ. Examples: *Bellis, *Aphanostephus. *Division* 3. *Chrysocomeæ.* *a,* Gymnospermeæ. Example: *Gymnosperma. *b,* Achyrideæ. Example: *Amphiachyris. *c,* Heterotheceæ. Example: *Bradburia. *d,* Psiadieæ, Erato. *e,* Chrysopsideæ. Example: Chrysopsis. *f,* Solidagineæ

Example: *Solidago. *Division* 4. *Solenogyneæ.* Example: Leptothamnus.

Sub-tribe 2. *Baccharideæ.* Heads diœcious, or heterogamous, never radiate; pistillate flowers tubular, slender, or filiform, in several series. Receptacle not chaffy. Anthers not caudate. *Division* 1. *Conyzeæ.* *a*, Sphœrantheæ. Example: Athroisma. *b*, Grangeineæ. Example: Grangea. *c*, Euconyzeæ. Example: *Conyza. *d*, Eubaccharideæ. Example: *Baccharis.

Sub-tribe 3. *Tarchonantheæ.* Heads diœcious, or heterogamous, never radiate; pistillate flowers, tubular and very slender, mostly in several series. Anthers caudate. *Division* 1. *Eutarchonantheæ.* Example: Tarchonanthus. *Division* 2. *Plucheineæ.* Example: *Pluchea, *Micropus.

Sub-tribe 4. *Inuleæ.* Heads heterogamous and radiate, or homogamous and discoid, never diœcious. Receptacle not chaffy. Anthers caudate. Leaves alternate. *Division* 1. *Euinuleæ.* Example: *Inula. *Division* 2. *Cæsulineæ.* Example: Cæsula.

Sub-tribe 5. *Bupthalmeæ.* Example: Bupthalmum.

Sub-tribe 6. *Eclypteæ.* Heads heterogamous, radiate. Receptacle chaffy. Anthers not caudate. Pappus toothed, or awned, or none. Leaves opposite. Examples: *Borrichia, *Eclipta.

Tribe 4. *Senecionideæ.* Style of the perfect flowers cylindraceous: the branches linear, truncate at the summit, and penicillate, or often produced into a conical or elongated hispid appendage; the stigmatic lines rather broad and prominent, extending to the commencement of the appendage or hairy portion.

Sub-tribe 1. *Melampodineæ.* Flowers all unisexual: the staminate and pistillate either occupying the same or different heads, in the same or different individuals. Anthers not caudate. Pappus never of bristles. *Division* 1. *Euxenieæ.* Example: Euxenia. *Division* 2. *Millerieæ.* Example: *Blennosperma. *Division* 3. *Silphieæ.* Examples: *Silphium, *Engelmannia. *Division* 4. *Melampodieæ.* Example: *Melampodium. *Division* 5. *Ambrosieæ.* Examples: *Ambrosia, *Xanthium. *Division* 6. *Iveæ.* Example: *Iva. *Division* 7. *Partheniеæ.* Example: *Parthenium.

Sub-tribe 2. *Heliantheæ.* Heads heterogamous and radiate, or homogamous and discoid. Receptacle partly or entirely chaffy. Pappus none, or coroniform, or awned, or of few squamellæ. Anthers blackish, not caudate. Leaves often opposite. *Division* 1. *Heliopsideæ.* Example: **Heliopsis.* *Division* 2. *Rudbeckieæ.* Example: *Rudbeckia. *Division* 3. *Coreopsideæ.* Example: *Coreopsis. *Division* 4. *Bidentideæ.* Example: *Bidens. *Division* 5. *Verbesineæ.* Example: *Spilanthes.

Sub-tribe 3. *Flaverieæ.* Heads one-, few-flowered, densely aggregated, heterogamous. Leaves opposite. Example: *Flaveria.

Sub-tribe 4. *Tagetineæ.* Heads heterogamous and radiate, or homogamous and discoid. Receptacle not chaffy. Pappus awned or setose. Involucre, with the scales in a single series, and mostly united, dotted, like the opposite leaves, with large pellucid glands. *Division* 1. *Tageteæ.*

Examples: *Dysodia, *Riddellia. *Division* 2. *Porophylleæ.* Example: Porophyllum.

Sub-tribe 5. *Helenieæ.* Heads mostly heterogamous. Pappus of several or numerous scarious, chaffy scales, in a single series, distinct, rarely none. Leaves mostly alternate (chiefly American). *Division* 1. *Gaillardieæ.* *a,* Eugaillardieæ. Example: *Gaillardia. *b,* Euhelenieæ. Example: *Hymenopappus. *Division* 2. *Galinsogeæ.* *a,* Eugalinsogeæ. Example: *Marshallia. *b,* Sphenogyneæ. Example: Ursinia. *Division* 3. *Madieæ.* Example: *Callichroa. *Division* 4. *Baldwinieæ.* Example: *Actinospermum.

Sub-tribe 6. *Anthemideæ.* Heads mostly heterogamous. Pappus none or coroniform, rarely squamellate. Anthers not caudate. Branches of the style truncate and bearded at the apex, rarely terminated by a short cone. Leaves mostly alternate. *Division* 1. *Euanthemideæ.* Examples: *Anthemis, *Achillea. *Division* 2. *Chrysanthemeæ.* Example: *Monolopia. *Division* 3. *Cotuleæ.* Example: *Aromia. *Division* 4. *Athanasieæ.* Example: Athanasia. *Division* 5. *Artemisieæ.* Examples: *Tanacetum, *Artemisia. *Division* 6. *Hippieæ.* Example: *Soliva. *Division* 7. *Eriocephaleæ.* Example: Eriocephalus.

Sub-tribe 7. *Gnaphalieæ.* Heads homogamous and discoid, rarely heterogamous. Anthers caudate. Pappus of capillary or setaceous bristles, rarely none. Leaves mostly alternate. *Division* 1. *Angiantheæ.* Example: Hyalolepis. *Division* 2. *Cassinieæ.* Example: Cassinia. *Division* 3. *Helichryseæ.* Examples: *Gnaphalium, *Filago. *Division* 4. *Seriphieæ.* Example: Seriphium. *Division* 5. *Antennarieæ.* Example: *Antennaria. *Division* 6. *Leyserreæ.* Example: Athrixia. *Division* 7. *Relhanieæ.* Example: Carpesium.

Sub-tribe 8. *Senecioneæ.* Heads homogamous or heterogamous, discoid or radiate. Anthers not caudate. Pappus of capillary bristles, or very rarely wanting in the exterior flowers. Leaves alternate. *Division* 1. *Neurolæneæ.* Example: Neurolæna. *Division* 2. *Erechtiteæ.* Example: *Erechtites. *Division* 3. *Eusenecioneæ.* Example: *Cacalia, *Senecio. *Division* 4. *Balbisieæ.* Example: Balbisia.

Tribe 5. *Cynareæ.* Style of the perfect flowers nodose-thickened, and often penicillate at the summit; the stigmatic lines not prominent, reaching to and confluent at the summit of the externally puberulent branches.

Sub-tribe 1. *Calendulaceæ* (none North American). *Division* 1. *Calenduleæ.* Example: Calendula. *Division* 2. *Osteospermeæ.* Example: Osteospermum. *Division* 3. *Othonneæ.* Examples: Heteractis.

Sub-tribe 2. *Arctotideæ* (none North American). *Division* 1. *Arctoteæ.* Example: Arctotis. *Division* 2. *Gorterieæ.* Example: Cullumia.

Sub-tribe 3. *Echinopsideæ* (none North American). Example: Acantholepis.

Sub-tribe 4. *Cardopateæ* (none North American). Example: Cardopatium.

Sub-tribe 5. *Xeranthemeæ* (none North American). Example: Chardinia.

Sub-tribe 6. *Carlinieæ.* Heads discoid, homogamous. Anthers caudate. Pappus mostly plumose. Example: Saussurea.

Sub-tribe 7. *Centaurieæ.* Heads discoid; the marginal flowers mostly neutral, usually much larger than the others. Pappus never plumose, sometimes wanting. Example: *Centaurea, *Cnicus.

Sub-tribe 8. *Carthameæ* (none North American). Example: Carthamus.

Sub-tribe 9. *Silybeæ* (none North American). Example: Silybum.

Sub-tribe 10. *Carduineæ.* Heads discoid, homogamous, sometimes diœcious. Anthers slightly or not at all caudate. Pappus of plumose or scabrous bristles. Examples: *Cirsium, *Carduus, *Lappa.

Sub-tribe 11. *Serratulæ* (none North American). Example: Serratula.

SUB-ORDER 2. LABIATIFLORÆ.

Tribe 6. *Mutisiaceæ.* Style of the perfect flowers cylindraceous or somewhat nodose above: the branches obtuse or truncate, externally very convex, and minutely pubescent above. Only one North American genus (Chaptalia).

Sub-tribe 1. *Mutisieæ* (none North American). *Division* 1. *Barnadesieæ.* Example: Schlechtendalia. *Division* 2. *Eumutisieæ.* Example: Mutisia.

Sub-tribe 2. *Lerieæ.* Example: *Chaptalia.

Sub-tribe 3. *Facelideæ* (none North American). Example: Facelis.

Tribe 7. *Nassauviaceæ.* Style of the perfect flowers not nodose, thickened above: the branches linear, rather long, truncate, penicillate at the summit. Only one North American genus (Acourtia).

Sub-tribe 1. *Polyachyrideæ.* Example: Polyachyrus.

Sub-tribe 2. *Nassauvieæ.* Example: Caloptilium.

Sub-tribe 3. *Trixideæ.* Example: *Acourtia.

SUB-ORDER 3. LIGULIFLORÆ.

Tribe 8. *Cichoraceæ.* Style cylindraceous above: the branches rather long and obtuse, equally pubescent, the stigmatic lines terminating below their middle. Plants with a milky juice. Leaves alternate.

Sub-tribe 1. *Scolymeæ* (none North American). Example: Scolymus.

Sub-tribe 2. *Lampsaneæ.* Pappus none. Receptacle not chaffy. Examples: *Lampsana, *Apogon.

Sub-tribe 3. *Hyoserideæ.* Pappus wholly or partly chaffy or squamellate. Receptacle not chaffy. Example: *Cichorium.

Sub-tribe 4. *Hypochærideæ* (none North American). Example: Oreophila.

Sub-tribe 5. *Scorzonereæ.* Pappus setose or plumose. Receptacle not chaffy. Examples: *Leontodon, *Rafinesquia.

Sub-tribe 6. *Lactuceæ.* Pappus capillary, not plumose. Receptacle not chaffy. Examples: *Hieracium, *Taraxacum, *Lactuca.

Of the 1000 genera indicated above, as embraced in this vast order, 200 are found in North America, or one fifth of the whole. Nearly all the sub-tribes, and most of the divisions indicated above, have representatives in this country. Of the entire order Labiatifloræ, however, there are but two genera, the rest being principally found on the western coast of South

America. In conclusion, we can but briefly name such plants as are conspicuous for their economical qualities. Cynara cardunculus, the Cardoon; C. scolymus, the Artichoke; Carthamus tinctorius, Safflower. Anthemis nobilis, Chamomile; Inula helenium, Elecampane; Artemisia absinthum, Wormwood. Moxas are formed from the woolly leaves of the Chinese Artemisia moxa. A. dracunculus is Tarragon; Tanacetum vulgare, Tansy; Helianthus, Sunflower; Cichorium intybus, Succory or Chicory; Taraxacum dens-leonis, Dandelion; Lactuca sativa, Lettuce; Tragopogon porrifolius, Salsify or Oyster plant.

Lactuca virosa, Poison Lettuce, Europe (*pl.* 64, *fig.* 9); *a*, a flower; *b*, ditto magnified; *d*, pistil; *e*, achænium; *f*, ditto magnified; *g*, hair of pappus magnified; *h*, cross-section; and *i*, longitudinal ditto of achænium.

Carthamus tinctorius, Safflower, East Indies (*pl.* 64, *fig.* 11); *a*, upper part; *b*, sepal from the interior; *c*, an inner involucral leaf; *d*, a flower; *e*, the anthers separated; *f*, a pappus hair magnified; *g*, achænium without the pappus.

Cynara scolymus, the Artichoke, Europe (*pl.* 64, *fig.* 10); *a*, a flower; *b*, the fruit without pappus.

Serratula tinctoria (*pl.* 64, *fig.* 12); A, the upper, B, the lower part of the plant; *a*, involucral scale; *b*, hermaphrodite flower; *c*, stigma; *d*, achænium; *e*, cross-section of ditto; *h*, a female flower.

Tanacetum vulgare, Tansy, Europe (*pl.* 64, *fig.* 13); *a*, involucral scale; *b*, anthers; *c*, ray, and *d*, disk flowers; *e*, pistil; *f*, achænium; *g*, cross-section of ditto.

Artemisia absinthum, Wormwood, Europe (*pl.* 65, *fig.* 1); *a*, a lower leaf; *b*, flowering branch; *c*, receptacle with a disk and ray flower still standing; *d*, ray flower; *e*, disk flower; *f*, stigma; *g*, achænium; *h*, ditto in cross-section.

Order 117. Calyceraceæ, the Calycera Family. Calyx superior, with a limb of five unequal segments. Corolla regular, infundibuliform, with a long, slender tube, and a five-lobed limb, the lobes having each three principal veins. Stamens five, attached to the tube of the corolla, with as many alternating glands below them; filaments monadelphous; anthers partially united. Ovary inferior, one-celled; ovule solitary, pendulous; style single, smooth; stigma capitate. Fruit an achænium, crowned by the rigid spiny segments of the calyx, sometimes covered with papillæ, which emit spiral tubes when placed in water. Seed solitary, pendulous; embryo in the axis of fleshy albumen; radicle superior. Herbaceous plants, with alternate, exstipulate leaves, and sessile capitate flowers, surrounded by an involucre. They inhabit South America. Their properties are unknown. There are five known genera, according to Lindley, and ten species. Examples: Calycera, Boopis.

Order 118. Dipsaceæ, the Teazel Family. Calyx superior, with an entire or toothed, or pappose limb. Corolla gamopetalous, tubular, inserted on the calycine tube, with an oblique four- or five-lobed limb; æstivation imbricated. Stamens four, attached to the tube of the corolla, and alternate with its lobes; anthers dithecal, distinct. Ovary cohering with the tube of

the calyx, either closely or only at the apex, unilocular; ovule solitary, pendulous, anatropal; style filiform; stigma simple. Fruit dry, indehiscent, crowned by the limb of the calyx, covered by an epicalyx, or involucellum, one-celled. Seed solitary, pendulous, albuminous; embryo straight; radicle superior. Herbs or undershrubs, with opposite or verticillate leaves, and capitate or verticillate flowers, surrounded by a many-leaved involucre. They are found in the south of Europe, the Levant, and at the Cape of Good Hope. None in North America. The properties of the order are unimportant. The heads of Dipsacus fullonum, Fuller's Teazel, on account of their spiny bracts, are used in dressing cloth. Lindley mentions six genera, including one hundred and fifty species. Examples: Morina, Scabiosa, Dipsacus.

Dipsacus fullonum, the Teazel, Europe (*pl.* 65, *fig.* 2): *a*, a flowering branch; *b*, vertical section of the head; *c*, a flower; *d*, ditto opened; *e*, stigma; *f*, achænium; *g* and *h*, sections of ditto.

ORDER 119. VALERIANACEÆ, the Valerian Family. Calyx superior, its limb being either membranous or pappose. Corolla gamopetalous, inserted into the top of the ovary, tubular, three-, four-, to five-lobed, sometimes gibbous or spurred at the base. Stamens one to five, adherent to the corolla and alternate with its lobes. Ovary inferior, one- to three-celled; ovule solitary, pendulous, style filiform; stigmas one to three. Fruit dry, indehiscent, crowned with the limb of the calyx, one-celled, in consequence of two cells being abortive. Seed solitary, pendulous, exalbuminous; embryo straight; radicle superior. Herbs, with opposite, exstipulate leaves, and cymose inflorescence. They are found in temperate climates. Lindley gives twelve genera, and 185 species.

The only North American genera are Valeriana, Plectritis, and Fedia. The root of Valeriana officinalis furnishes the medicinal valerian; this substance produces a species of intoxication in cats. Nardostachys jatamansi is the nardos or spikenard of the ancients.

ORDER 120. RUBIACEÆ, the Madder and Cinchona Family. Tube of the calyx adherent to the ovary, rarely partly, or almost completely free; the limb mostly four- to five-cleft or toothed, sometimes obsolete. Corolla inserted upon the summit of the calyx-tube, composed of as many united petals as there are lobes of the calyx, valvate, imbricate, or somewhat contorted in æstivations. Stamens inserted into the tube of the corolla, equal in number and alternate with its lobes (or very rarely fewer); anthers introrse. Ovary two- (rarely three-, several-) celled, with one, or many ovules in each cell; style single or partly divided; stigmas distinct or concrete. Fruit capsular, drupaceous, baccate, or separated into indehiscent carpels. Seeds anatropous or amphitropous, solitary, few, or numerous in each cell. Embryo straight or slightly curved, in the axis or at the extremity of copious densely fleshy or horny albumen. Trees, shrubs, or herbs, with opposite, or rarely verticillate, entire leaves. Stipules between the petioles, sometimes simulating the leaves. Flowers regular. Inflorescence various.

SUB-ORDER 1. COFFEACEÆ. Cells one- to two-seeded.

Tribe 1. *Operculariecæ.* Flowers close pressed in a capitulum, in which they are united by their unilocular one-seeded ovaries. Fruit dehiscent. Herbs or undershrubs of Australia. Example: Pomax.

Tribe 2. *Galieæ, or Stellatæ.* Ovary with two one-seeded cells. Carpels indehiscent, dry or fleshy, separating from each other at maturity. Whorls of straight leaves, of which two opposite ones alone carry buds in their axils, the others perhaps transformed stipules. Herbs or undershrubs of temperate and cold climates. Examples: *Galium, Rubia.

Tribe 3. *Anthospermæ.* Flowers distinct. Ovary with two one-seeded cells. Carpels indehiscent, dry, separating at maturity. Stipules small, petiolar. Herbs or undershrubs of the Cape, of the Canaries, very rarely of Australia. Example: Anthospermum.

Tribe 4. *Spermacoceæ.* Flowers distinct. Ovaries of two to four cells, one- to two-seeded. Carpels dry or fleshy, never loculicidal, dehiscent or not. Æstivation of the corolla valvate. Stipules membranaceous at the base, usually with several bristles at the apex. *Sub-tribe* 1. *Euspermacoceæ.* Examples: *Spermacoce, *Borreria, *Diodia. *Sub-tribe* 2. *Putorieæ.* Example: *Ernodia. *Sub-tribe* 3. *Cephalantheæ.* Example: *Cephalanthus.

Tribe 5. *Psycotrieæ.* Flowers distinct. Ovary of two one-seeded cells. Fruit fleshy, with two nucules. Perisperm horny. Stipules interpetiolar, distinct or connate. Trees or shrubs of tropical or juxtatropical regions, especially American. Examples: *Chiococca, *Psycotria, Coffea.

Tribe 6. *Pæderieæ.* Flowers distinct. Ovary of two one-seeded cells. Fruit of two compressed shells which become detached from the calyx, and remain suspended by a filiform axis. Lianas of intertropical regions. Example: Lecontea.

Tribe 7. *Guettardeæ.* Flowers distinct or combined together. Ovary of two or more one-seeded cells. Drupe with the like number of nucules. Albumen fleshy. Stipules axillar or interpetiolar, connate. Trees or shrubs of tropical regions. *Sub-tribe* 1. *Morindeæ.* Example: *Morinda. *Sub-tribe* 2. *Mitchelleæ.* Example: *Mitchella. *Sub-tribe* 3. *Euguettardeæ.* Example: *Guettarda, *Erithalis.

Tribe 8. *Cordierieæ.* Flowers distinct or separate. Ovary of two to five one-seeded cells. Fruit a berry. Perisperm fleshy. Stipules interpetiolar, large, and adnate. Shrubs of tropical regions. Example: Cordiera.

Sub-order 2. Cinchonaceæ. Cells many-seeded.

Tribe 9. *Hamelieæ.* Berry many-celled. Cells many-seeded. Example: *Hamelia.

Tribe 10. *Isertieæ.* Fruit drupaceous, with many nucules. Ex.: Isertia.

Tribe 11. *Hedyotideæ.* Fruit capsular, seeds not winged. Example: Hedyotis.

Tribe 12. *Cinchoneæ.* Fruit capsular. Seeds winged. Example: *Pickneya, *Exostemma, Cinchona.

Tribe 13. *Gardenieæ.* Berry one- to two-locular. Seeds not winged. Example: Sarcocephalus, Catesbœa.

The entire order, as at present composed, embraces 280 genera (sixteen North American) and upwards of 2800 species. The most important

medicinal species are those belonging to the sub-order Cinchonaceæ. Peruvian bark is furnished by various species (about twelve) of Cinchona. It owes its efficacy to two alkaloids, Cinchonia and Quina. The bark of Pinckneya pubens has properties somewhat similar to that of true Cinchonas. Ipecacuanha is the root of Cephælis ipecacuanha, a Brazilian plant. The coffee plant, Coffea arabica, likewise belongs to this order. It is originally a native of Arabia and the borders of Abyssinia. Rubia tinctoria yields madder, a very valuable dye.

Rubia tinctoria, madder (*pl.* 65, *fig.* 3); *a*, the root; *b*, a flowering branch; *c, d, f*, flowers; *e*, pistil; *g*, anthers.

Coffea arabica, coffee (*pl.* 65, *fig.* 4); *a*, a branch with flowers and fruit; *b*, pistil; *c*, flower expanded; *d*, fruit; *e*, do. with part of the hull removed, showing the two seeds; *f*, a seed; *g*, cross-section.

Order 121. Caprifoliaceæ, the Honeysuckle Family. Tube of the calyx adherent to the ovary; the limb five- (rarely four-) cleft or toothed. Corolla tubular, or sometimes rotate; the lobes imbricate in æstivation. Stamens equal in number and alternate with the lobes of the corolla (or rarely one of them deficient), and inserted into the tube; anthers introrse, versatile. Ovary three- (rarely four- to five-) celled, with one to several pendulous ovules in each cell; style filiform, with a somewhat capitate stigma; or wanting, and the oblong stigmas three to five. Fruit baccate, fleshy, or sometimes dry (rarely capsular), often one-celled by abortion. Seeds anatropous. Embryo in the axis of fleshy albumen. Shrubs, or rarely herbaceous plants, with opposite exstipulate leaves. Inflorescence various. Chiefly found in the northern parts of Europe, Asia, and America.

Sub-order 1. *Lonicereæ.* Corolla tubular; the limb sometimes irregular. Style filiform. Raphe on the outer side of the ovule. *Tribe* 1. *Caprifolieæ.* Fruit baccate, sometimes nearly dry. Testa of the seed crustaceous or coriaceous. Examples: *Linnæa, *Symphoricarpus, *Lonicera, *Diervillea. *Tribe* 2. *Triosteæ.* Fruit drupaceous; endocarp bony. Testa of the seed membranaceous. Example: *Triosteum.

Sub-order 2. *Sambuceæ.* Corolla regular, rotate, or rarely somewhat tubular. Stigmas three to five, nearly sessile. Endocarp of the fruit crustaceous or coriaceous. Testa of the seed membranaceous, the raphe occupying the inner side. Examples: *Sambucus, *Viburnum.

Lindley assigns fourteen genera and 220 species to this family, of which eight genera and thirty-seven species are North American; of these, twelve are species of Viburnum, and fifteen of Lonicera. The snow-berry, a common ornamental shrub, is Symphoricarpus racemosus. The Elder (Sambucus), Honeysuckle (Lonicera), are well known plants. Linnæa borealis is a charming species found in the north of the United States and of Europe.

Lonicera caprifolium, Honeysuckle (Europe) (*pl.* 65, *fig.* 5); *a*, a flowering branch; *b*, a flower expanded; *c*, anther; *d*, pistil; *e*, fruit; *f*, sections of do.; *g*, a seed.

Order 122. Loranthaceæ, the Mistletoe Family. Perianth in the

unisexual flowers sometimes none, or often simple (calyx), adnate to the ovary in the fertile flowers, three- to five-cleft in the sterile flowers; in the perfect flowers double, viz. calyx adnate to the ovary; the limb entire or denticulate, or often obsolete. Corolla of three to four or eight petals, either distinct, or more or less coherent in a tube, inserted into the epigynous disk; æstivation valvate. Stamens equal in number with the petals and opposite them, or as many as the segments of the calyx, and inserted upon them when the perianth is simple. Ovary one-celled, with a single suspended ovule; style simple, or none. Fruit baccate, one-celled, one-seeded. Seed anatropous; the membranous testa often adhering to the walls of the fruit. Embryo in a superficial cavity of the fleshy albumen; radicle clavate, often exserted; cotyledons obtuse, sometimes connate. Parasitical, half-shrubby, evergreen plants, with dichotomous stems. Leaves mostly opposite, fleshy or coriaceous, almost veinless; sometimes reduced to scales or entirely wanting. Stipules none. Flowers unisexual and small (whitish or greenish yellow), or perfect and very showy.

Many of the plants are tropical, and hang from the trunks and branches of trees; others occur in temperate regions. Lindley gives 23 genera and 412 species, of which two genera, Viscum and Arceuthobium, with three species, are North American. Viscum album is the mistletoe of English writers.

Sub-class 3. *Calyciflorœ.*

In this division are included the polypetalous orders of Jussieu, in which the stamens are not hypogynous, as well as some diclinous orders. A calyx and corolla are present; in other words, the plants are dichlamydeous, the petals are distinct, and the stamens are attached to the calyx, being thus more or less perigynous. This sub-class, along with Thalamifloræ, comprises the Dialypetalæ of Endlicher. De Candolle included in this division gamopetalous plants, in which the ovary is inferior.

ORDER 123. CORNACEÆ, the Dogwood Family. Calix, four-lobed. Petals four, oblong, broad at the base, regular, inserted into the upper part of the calycine tube; æstivation valvate. Stamens four, inserted along with the petals, and alternate with them; anthers dithecal. Ovary adherent to the tube of the calyx, two-celled, crowned by a disk; ovules solitary, pendulous, anatropal; style filiform; stigma simple. Fruit fleshy, crowned by the limb of the calyx, two-celled, rarely one-celled by abortion; endocarp bony. Seeds solitary, pendulous; embryo straight, long in the axis of fleshy albumen; radicle superior, shorter than the oblong cotyledons. Trees, shrubs, or herbs, with opposite, very rarely alternate, exstipulate leaves, and capitate, umbellate, or corymbose flowers. They inhabit the temperate climates of Europe, Asia, and America. The most prominent North American species of this family is Cornus florida, or the Dog wood, a showy member of our forests. Lindley enumerates nine genera and forty species, of which but one genus (Cornus), with eleven species, belongs to North America.

ORDER 124. ARALIACEÆ, the Ginseng Family. Calyx entire or toothed. Petals definite, two- to five- or ten-deciduous, occasionally 0; æstivation valvate. Stamens, as many as the petals, or twice as many, inserted below the margin of an epigynous disk. Ovary adherent to the tube of the calyx, two- or more-celled; ovules solitary, pendulous, anatropal; styles, two or more, distinct or connate; stigmas simple. Fruit usually succulent, two- to fifteen-celled, covered by the calycine limb. Seeds solitary, pendulous, adhering to the endocarp; albumen fleshy; embryo small; radicle pointing to the hilum. Trees, shrubs, or herbaceous plants, with alternate, exstipulate leaves, and umbellate or capitate flowers. They are found both in tropical and in cold regions. Lindley enumerates 21 genera, including 160 species. Examples: Aralia, Panax, Adoxa, Hedera. The first three genera, with eight species, are the only North American.

The plants of this order are allied to Umbelliferæ, but do not possess poisonous qualities to any very marked degree. A species of Panax yields the Ginseng of the Chinese, for which a North American species, P. quinquefolium, serves as a substitute. An arborescent species, P. horridum, forms almost impenetrable thickets in Oregon. Aralia nudicaulis is used in the United States under the name of Sarsaparilla. The Ivy, Hedera helix, belongs to this order.

Aralia nudicaulis, Sarsaparilla (not the true), United States (*pl.* 65, *fig.* 6): *a*, a compound leaf; *b*, flower branch; *c*, a flower-bud; *d*, an open flower; *e*, petal; *f*, pistil; *g*, cross-section of ovary; *h*, ripe berry; *i*, seed.

ORDER 125. UMBELLIFERÆ, the Umbelliferous Family. Calyx adherent to the ovary; the limb very small, five-toothed, or entire. Petals five, inserted on the outside of the epigynous disk, usually inflexed at the point, the inflexed portion cohering with the lamina; æstivation somewhat imbricate, or rarely valvate. Stamens five, alternate with the petals, inflexed in æstivation; anthers ovate, introrse. Ovary composed of two (very rarely more) united carpels, invested with the coherent calyx, two-celled, with a solitary suspended ovule in each cell: styles two, their bases dilated and thickened into a fleshy body (*stylopodium*), which covers the top of the ovary; stigmas simple. Fruit consisting of two dry carpels (often termed *mericarps*), which adhere by their faces (*commissure*) to a common axis (*carpophore*), at length separating from each other, and suspended from the summit of the carpophore, each carpel indehiscent, marked with five longitudinal primary ribs, one opposite each petal and each stamen, and often with five alternating secondary ones; in the substance of the pericarp are usually several longitudinal canals or receptacles (*vittæ*), filled with a colored aromatic oil or turpentine, which are commonly lodged in the spaces (*intervals*) between the ribs, but sometimes opposite them. Seed anatropous, usually coherent with the carpel, rarely loose. Embryo minute at the base of the copious horny albumen. Herbs, or rarely suffrutescent plants: the stems usually fistular and furrowed. Leaves alternate (or very rarely opposite), usually pinnately or ternately divided; the petioles mostly dilated and sheathing at the base Flowers in umbels, usually with an involucre.

This extensive order is divided by De Candolle into three sub-orders: *Orthospermæ*, having the inner face of the seed and albumen plane, neither convolute nor involute; *Campylospermæ*, albumen with a longitudinal groove internally, or the margins involute; and *Cœlospermæ*, albumen involute at the base and apex.

Sub-order 1. Orthospermæ.

Tribe 1. *Hydrocotyleæ.* Fruit laterally compressed: carpels convex or (rarely) acute on the back; primary ribs five, sometimes obsolete; the lateral ones either marginal or on the face of the commissure; the intermediate ones most prominent; secondary ribs sometimes persistent and filiform, sometimes almost or entirely wanting. Vittæ very seldom present. Seed flattish on the face. Umbels simple or imperfectly compound. Mostly tropical. Examples: *Hydrocotyle, *Bowlesia, Centella.

Tribe 2. *Mulineæ.* Carpels contracted at the commissure, flattened on the back, five-jugate, forming a quadrangular fruit. The species are mostly inhabitants of extra-tropical South America. Examples: Bolax, Huanaca.

Tribe 3. *Saniculeæ.* Transverse section of the fruit somewhat orbicular. Carpels with five equal primary and no secondary ribs, or covered with scales or prickles, when the ribs are obliterated. Vittæ none, or numerous when the fruit is prickly. Seed flattish on the face. Umbels fascicled or capitate, simple, or somewhat irregularly compound. Mostly American, between 35° N. L. and 45° S. L. Examples: *Sanicula, *Eryngium, Astrantia.

Tribe 4. *Ammineæ.* Fruit evidently compressed laterally, and usually somewhat didymous. Carpels with five equal filiform and sometimes slightly winged primary ribs; the lateral ones marginal; secondary ribs none. Vittæ various. Seed gibbously convex on the back, and flattish on the face, or terete. Umbels perfectly compound. Mostly inhabitants of the temperate regions of both continents. Examples: *Ammi, *Cicuta, *Sium, Carum.

Tribe 5. *Seselineæ.* Transverse section of the fruit orbicular or nearly so. Carpels with filiform or winged ribs, of which the lateral ones are marginal, and either equal to or a little broader than the others. Intervals with one or more vittæ, very rarely without any. Seed somewhat teretely convex on the back, flattish on the face. Umbels perfectly compound. Distribution of the species as in the preceding tribe. Examples: *Thapsium, *Conioselinum, Lichtensteinia.

Tribe 6. *Pachypleureæ.* Carpels compressed, lentiform, five-jugate, with thick equal ribs. Inhabitants of Central Asia, South Africa, and the Mediterranean region. Example: Krubera.

Tribe 7. *Angeliceæ.* Fruit dorsally compressed, with a double winged margin. Carpels with the three dorsal ribs filiform or winged; the lateral ones dilated and forming the winged margins. Seed convex on the back, flattish on the face. Umbels compound. Mostly inhabit central and northern Europe: a few found in Northern America and Asia. Examples: *Angelica, *Archangelica, Selinum.

Tribe 8. *Peucedaneæ.* Fruit more or less compressed dorsally, surrounded with a single dilated entire smooth margin, which is flattened or slightly convex, but not thickened at the edge. Carpels with five filiform or rarely winged ribs, of which the lateral ones are contiguous to the dilated margin or united with it. Seed flattened, or convex on the back. Rare in western Europe, northern America, and the Canaries; more abundant in northern India and South Africa. Examples: *Peucedanum, *Pastinaca, Anethum.

Tribe 9. *Silerineæ.* Fruit multijugate, the ribs but little elevated, especially the secondary; carpels compressed externally. Inhabit central Europe and northern Asia. Examples: Siler, Galbanum.

Tribe 10. *Cumineæ.* Fruit contracted at the sides. Carpels with five primary filiform ribs, of which the lateral ones are marginal; and four more prominent secondary ones; all of them wingless. Seed straight, flattish on the face. Umbels compound. Found in Mediterranean Europe and in North America. Examples: *Trepocarpus, Cuminum.

Tribe 11. *Thapsieæ.* Fruit either dorsally compressed or nearly terete. Carpels with five filiform, often bristly, primary ribs, of which the lateral ones are placed on the face of the commissure: secondary ribs four; the dorsal ones filiform and the lateral ones winged; or all of them winged (hence the fruit is either eight-winged, or only two-winged on each side). Seed flattish, or somewhat teretely convex, plane on the face. Umbels compound. Central Europe and north-western America. Examples: *Laserpitium, Thapsia.

Tribe 12. *Daucineæ.* Fruit lenticularly compressed on the back, or somewhat terete. Carpels with five filiform bristly primary ribs, of which the latter are placed on the flat commissure; and four more prominent prickly secondary ones, the prickles distinct or united into a wing. Seed flattened or convex on the back, flattish on the face. Umbels compound. Southern Europe and Asia, northern Africa, extra-tropical America. Examples: Artedia, Daucus.

Sub-order 2. Campylospermeæ.

Tribe 13. *Elæoselineæ.* Fruit cylindrical, multijugate; primary ribs filiform, the lateral secondary alate. Species Mediterranean, a single one Mexican. Example: Elæoselinum, Margotia.

Tribe 14. *Caucalineæ.* Fruit laterally contracted or somewhat terete. Carpels with five primary bristly or prickly ribs, of which the lateral ones are in the commissure; secondary ribs four, more prominent and prickly, or sometimes obliterated by the copious prickles filling the entire intervals. Seed involute, or with the margin inflexed. Umbels compound. Distribution as in Daucineæ; one North American species. Examples: *Caucalis, Torilis.

Tribe 15. *Scandicineæ.* Fruit compressed or contracted laterally, usually rostrate. Carpels with five equal filiform or winged ribs, of which the lateral ones are marginal; all of them sometimes obliterated at the base and only conspicuous at the apex. Seed teretely convex, either furrowed on the face or involute. Umbels compound. Central and southern

Europe, Asia, and America. Examples: Chœrophyllum, *Glycosma, Tauschia.

Tribe 16. *Smyrnieæ.* Fruit turgid, mostly laterally compressed or contracted. Carpels with five ribs; the lateral ones marginal or placed opposite the margin, sometimes nearly obliterated. Seed involute, or sulcate on the face. Umbels compound. Abundant in eastern Europe and Asia; rare in northern and tropical America. Examples: Conium, *Cynapium, Anosmia.

Sub-order 3. Cœlospermeæ.

Tribe 17. *Coriandreæ.* Fruit globose, or the carpels sub-globose and didymous; primary ribs of each carpel five, depressed and flexuous, or nearly obsolete; the secondary ones four, more prominent: all wingless. Umbels compound. Mediterranean Europe and Asia; North America. Examples: *Atrema, *Erigenia, Corion.

Many of the Umbelliferæ are valuable for various purposes. Some are esculents, as Daucus carota, the carrot; Pastinaca sativa, the parsnip; Apium graveolens, celery; Petroselinum sativum, parsley, &c. The roots of Arracacha esculentum, a native of Grenada, may serve as a substitute for the potatoe. Some species yield fœtid resins, as assafœtida, from Ferula assafœtida, a native of Persia. Caraway seeds are the fruit of Carum carui; coriander seeds, of Coriandrum sativum. Many are highly poisonous, as Conium maculatum, Water Hemlock.

Lindley enumerates 267 genera, embracing 1500 species. Of these, fifty genera and about 140 species are North American.

Chærophyllum temulum, Europe (*pl.* 65, *fig.* 10); *a*, a lower leaf; *b*, lower part of the stem; *c*, a flower branch; *d*, a flower; *e*, the fruit.

Conium maculatum, Hemlock, Europe (*pl.* 65, *fig.* 11); *a*, cross-section of stem; *b*, flowering branch with flowers and fruit; *c*, involucre; *d*, flower; *e*, pistil; *f*, fruit; *g*, cross-section of achænium.

Cicuta virosa, Water Hemlock, or Cow-bane, Europe (*pl.* 65, *fig.* 8); *a*, vertical section of the root; *b*, flower branch; *c*, flower; *d*, pistil; *e*, achænia; *f*, cross-section of ditto; *g*, vertical section of achænium.

Æthusa cynapium, Fool's Parsley, Europe (*pl.* 65, *fig.* 9); *a*, cross-section of the stem; *b*, branch with flowers and fruit; *c*, flower; *d*, achænia.

Œnanthe fistulosa, Dead Tongue, Europe (*pl.* 65, *fig.* 7); *a*, the entire plant; *b*, *c*, flowers; *d*, pistil; *e*, involucre; *f*, anther; *g–l*, fruit.

Sium latifolium, Water Parsley, Europe and Northern America (*pl.* 65, *fig.* 12); *a*, flowering branch; *b*, a lower leaf; *c*, flower; *d*, pistil; *e*, fruit; *f–h*, achænium with longitudinal and transverse sections of ditto.

Order 126. Hamamelidaceæ, the Witch-hazel Family. Calyx four- or five-lobed or truncate. Petals four or five or 0, inserted on the calyx, alternating with the calycine segments. Stamens twice as many as the petals, in two rows, one of which alternates with the petals and is fertile, the other is opposite to them and sterile; anthers bilocular, introrse. Ovary adherent, two-celled; ovules solitary or several (in Bucklandia and Sedgwickia), pendulous or suspended; styles two. Fruit, a two-celled, two-valved capsule, opening by loculicidal dehiscence. Seeds pendulous;

embryo straight, in the axis of a fleshy albumen; cotyledons leafy; radicle superior. Shrubs or small trees, with alternate, petiolate, feather-veined, and stipulate leaves, and small axillary, bracteated, often unisexual flowers. They are found in various parts of Asia, Africa, and America. There are ten genera, with fifteen species. Of these North America possesses two genera and two species.

Tribe 1. *Hamameleæ.* Stamens eight to ten, of which the alternate ones are alone fertile; filaments very short. Ovules solitary in each cell. Examples: *Hamamelis (H. virginica, Witch-hazel, U. S.), Trichochladus.

Tribe 2. *Fothergillieæ.* Apetalous. Stamens somewhat indefinite; all fertile; filaments very long. Ovules one, solitary in each cell. Examples: *Fothergilla, Parrotia.

Tribe 3. *Bucklandieæ.* Cells with several ovules. Examples: Bucklandia, Sedgwickia.

Order 127. Bruniaceæ, the Brunia Family. Calyx five-cleft; æstivation imbricated. Petals inserted in the throat of the calyx, and alternate with its segments. Stamens alternate with the petals arising from them, or from a disk surrounding the ovary; anthers introrse, two-celled, with longitudinal dehiscence. Ovary usually adherent to the tube of the calyx, and one- to three-celled; ovules anatropal, suspended, one or two in each cell; style simple or bifid; stigmas one to three. Fruit either bicoccous and two-celled, or indehiscent and one-celled, crowned by the persistent calyx. Seeds solitary or in pairs, suspended, sometimes with a short arillus; embryo minute, at the base of fleshy albumen; cotyledons short and fleshy; radicle conical, next the hilum. Branched, heath-like shrubs, with small, imbricated, rigid, and entire leaves, and small, often capitate flowers. They are natives principally of the Cape of Good Hope, and have no important properties. There are fifteen known genera, according to Lindley, and sixty-five species Examples: Brunia, Staavia, Ophiria.

Order 128. Saxifragaceæ, the Saxifrage Family. Calyx superior, or more or less inferior; sepals usually five, more or less cohering at the base. Petals usually five, perigynous, alternate with the lobes of the calyx, rarely 0. Stamens perigynous, five to ten or ∞, in one or more rows; anthers bilocular, with longitudinal or porous dehiscence. Disk often present, either annular or scaly. Ovary more or less completely united to the tube of the calyx, consisting usually of two carpels, cohering by their face, but distinct and diverging at the apex; styles as many as the carpels, distinct or combined; stigmas capitate or clavate. Placentas marginal (basal or apicilar), rarely central. Fruit generally a one- or two-celled capsule, the cells dehiscing at the ventral suture, and often divaricating when ripe. Seeds usually ∞, rarely definite; spermoderm often reticulated; embryo small, in the axis of fleshy albumen; radicle pointing to the hilum. Shrubs, or trees, or herbs, with alternate or opposite, usually exstipulate leaves. They are generally natives of temperate climates, and some of them characterize alpine districts. The order has been divided into the following sub-orders:

Sub-order 1. *Saxifrageæ.* Petals five or 0; stamens five to ten; ovary

more or less adherent; styles usually two, and distinct; herbs with alternate, usually exstipulate leaves. Examples: *Saxifraga, *Heuchera, *Mitella.

Sub-order 2. *Escalloniecæ.* Petals and stamens five; ovary inferior; style simple; albumen oily. Evergreen shrubs, with alternate, simple, exstipulate leaves, found in the temperate regions of South America (one species, Itea virginica, North America), often at great elevations. Examples: Escallonia, *Itea.

Sub-order 3. *Hydrangeæ.* Petals four to six; stamens eight to twelve, or ∞; anthers sometimes biporose; ovary more or less inferior; styles two to five, usually distinct. Shrubs with opposite, sometimes whorled, exstipulate leaves; flowers frequently cymose, with the exterior flower sterile and dilated. Found chiefly in the temperate parts of Asia and America. Examples: *Hydrangea, *Decumaria.

Sub-order 4. *Cunoniaceæ.* Petals four to five, or 0; stamens eight to ten, or ∞; ovary half inferior; styles two, distinct or combined: trees or shrubs with opposite leaves, having interpetiolary stipules. Natives of South America, East Indies, South Africa, and Australia. Example: Codia.

The entire order contains fifty-seven genera and upwards of nine hundred species. North America has fifteen genera and ninety species (Saxifraga alone has forty-six). Saxifraga granulata, Europe (*pl.* 69, *fig.* 2); *a*, tubers; *b*, upper part of the plant; *c*, coronal scale; *d*, sexual apparatus; *e*, calyx with capsule; *f*, vertical section of ditto; *g–h*, seeds.

Order 129. Philadelphaceæ, the Mock Orange Family. Calyx, with a four- to ten-divided, persistent limb. Petals alternate with the divisions of the calyx, and equal to them in number; æstivation convolute. Stamens ∞ (rarely ten), in one or two rows, arising from the orifice of the calyx. Ovary adherent to the tube of the calyx; styles distinct or united into one; stigmas four to ten; ovules ∞, attached to a central placenta. Fruit, a four- to ten-celled capsule, free above. Seeds ∞, scobiform, subulate, smooth, pendulous, with a loose membranous arillus; albumen fleshy; embryo straight, about as long as the albumen; cotyledons flat; radicle next the hilum, obtuse. Shrubs with deciduous, opposite, exstipulate leaves, without dots; flowers usually in trichotomous cymes. They are natives of the south of Europe, of North America, Japan, and India. They have no marked properties. The flowers of Philadelphus coronarius, Syringo, have a peculiar sweetish odor, which, to some persons, is overpowering and disagreeable. Of the single genus Philadelphus five species are found in North America.

Order 130. Grossulaceæ or Ribesiaceæ, the Gooseberry Family. Calyx four- to five-cleft, regular, colored. Petals minute, perigynous, equal in number to the segments of the calyx, and alternate with them. Stamens four to five, alternate with the petals, and inserted into the throat of the calyx; filaments short; anthers dithecal. Ovary unilocular, adherent to the tube of the calyx; ovules ∞, anatropal, attached to two opposite parietal placentas; style single, two- to four-cleft. Fruit a one-celled berry, crowned with the remains of the flower. Seeds ∞, immersed in pulp, and

attached to the placentas by long thread-like funiculi; spermoderm gelatinous externally; albumen horny; embryo straight, minute; radicle pointing to the hilum. Shrubs with alternate lobed leaves, having a plicate vernation. They are natives of temperate regions, and are found in Europe, Asia, and America. Many yield edible fruits, which sometimes contain malic acid. The various kinds of Gooseberry (*Ribes grossularia*), and Currant (*Ribes rubrum* and *nigrum*) belong to this order. It contains two or three genera, and nearly one hundred species. Examples: Ribes, Robsonia. The family is represented in North America by the genus Ribes with twenty-eight species.

Order 131. Cactaceæ, the Cactus Family. Sepals numerous, usually ∞, and confounded with the petals; adherent to the ovary. Petals numerous. usually indefinite, sometimes irregular, inserted at the orifice of the calyx. Stamens indefinite, cohering more or less with the petals and sepals; filaments long, filiform; anthers ovate, versatile. Ovary fleshy, inferior, unilocular; style filiform; stigmas numerous; ovules ∞, attached to parietal placentas equal in number to the stigmas. Fruit succulent, one-celled. Seeds ∞, parietal, or, after losing their adhesion to the placenta, nestling in pulp, ovate or obovate; albumen 0; embryo straight, curved, or spiral; cotyledons thick, leafy, sometimes nearly obsolete; radicle thick, obtuse, next the hilum. Succulent shrubs, with peculiar angular or flattened stems, having the woody matter often arranged in wedges. Leaves usually absent; when present, fleshy, smooth, entire, or spinous. Flowers sessile, sometimes showy. They grow in hot, dry, and exposed places, and are natives chiefly of the tropical parts of America. Some grow rapidly on the lava in volcanic countries. There are sixteen known genera, and about eight hundred species. Examples: *Opuntia, *Mammillaria, *Echinocactus, *Cereus, &c. These genera, with numerous species, represent the order in (extra-Mexican) North America.

The plants of this order are remarkable for their succulence, for the great development of their cellular tissue, and for the anomalous forms of their stems, which sometimes are of great size. Opuntia vulgaris or prickly pear yields an agreeable fruit. The Night Blooming Cereus (Cereus grandiflorus) expands its large fragrant flowers only about ten p.m., which become withered before morning.

Cereus hexagonus (*pl.* 69, *fig.* 3); *b*, spines magnified.

Order 132. Ficoideæ or Mesembryanthaceæ, the Ficoid or Mesembryanthemum Family. Sepals definite, usually five, but varying from four to eight, more or less combined at the base, adherent to the ovary or distinct from it, equal or unequal; æstivation valvate or imbricate. Petals indefinite, colored, sometimes 0. Stamens perigynous, distinct, definite, or indefinite; anthers oblong, incumbent. Ovary usually plurilocular; stigmas several, distinct; ovules 00, anatropal or amphitropal, attached by cords to the placenta, which is either central or parietal. Fruit a many-celled capsule, opening in a stellate or circumscissile manner at the apex, or an indehiscent nut. Seeds 00, rarely definite or even solitary; embryo curved or spiral on the outside of mealy albumen; radicle next the hilum. Herbaceous or

shrubby succulent plants, with opposite or alternate simple leaves. They are found in warm regions chiefly. The greater part of them grow at the Cape of Good Hope. The order has been divided into three sections: 1. Mesembryeæ, numerous conspicuous petals, plurilocular capsule, with stellate dehiscence. 2. Tetragonieæ, petals 0, fruit woody and indehiscent. 3. Sesuveæ, petals 0, capsule with circumscissile dehiscence. There are sixteen known genera, and 440 species. Examples: Mesembryanthemum, Tetragonia, Aizoon, Sesuvium. No species of this order are native to North America. Mesembryanthemum crystallinum is often cultivated in green-houses under the name of ice-plant, so called from the peculiar appearance of the leaves.

Mesembryanthemum rubrocinctum (*pl.* 69, *fig.* 5).

Order 133. Crassulaceæ, the House-leek Family. Sepals three to twenty, more or less united at the base. Petals equal to the sepals in number, inserted in the bottom of the calyx, either distinct, or cohering in a gamopetalous corolla. Stamens inserted with the petals, either equal to them in number, and alternate with them, or twice as many, those opposite the petals being shortest; sometimes one or two rows of abortive stamens; filaments distinct or united, subulate; anthers bilocular, dehiscing longitudinally or transversely. Abortive stamens or scales (sometimes obsolete), at the base of each carpel. Carpels equal in number to the petals and opposite to them, one-celled, sometimes consolidated; styles several or combined; stigmas pointed or four-cornered; ovules 00, or definite, anatropal. Fruit consisting of several follicles, dehiscing by the ventral suture, sometimes by the dorsal suture. Seeds variable in number; embryo straight, in the midst of fleshy albumen; radicle pointing to the hilum. Herbaceous plants or shrubs, often succulent, with simple, entire, or pinnatifid, exstipulate leaves. They are found in the driest situations, as on rocks, walls, and sandy plains, in various parts of the world.

Tribe 1. *Crassuleæ.* Carpels (follicles) distinct; dehiscent by the inner suture. *Sub-tribe* 1. *Isostemones.* Stamens equal in number to the petals. Section *a.* Eucrassuleæ. Examples: *Tillæa, Crassula. Section *b.* Rocheæ. Example: Rochea. *Sub-tribe* 2. *Diplostemones.* Stamens twice as many as the petals. Section *a.* Umbiliceæ. Example: *Echeveria. Section *b.* Sedeæ. Examples: *Sedum, Sempervirum.

Tribe 2. *Diamorpheæ.* Carpels more or less united, dehiscent by the separation of the dorsal portion. Examples: *Diamorpha, *Penthorum. Some of the plants of this order are acrid, as Sedum acre; Sempervivum tectorum is known as the House-leek. There are five genera, with twenty species, in North America.

Sedum acre, Stone crop, Europe (*pl.* 69, *fig.* 1); *a*, the plant; *b*, a flower; *c*, the five carpels; *d*, one of the same; *e*, *f*, seeds; *g*, leaves.

Order 134. Surianaceæ. Sepals five, persistent; æstivation twisted, imbricated. Petals five, alternate with the sepals, distinct, inserted into the bottom of the calyx. Stamens five, alternate with the petals, sometimes with five alternating ones, that are occasionally abortive, all inserted with the petals; filaments persistent, distinct, subulate from a broad base, hairy

below; anthers two-celled, bursting longitudinally. Torus fleshy, filling up the bottom of the calyx, supporting the ovaries on its middle and the petals and stamens on its margin. Ovaries five, opposite to the petals, distinct, each with a long style arising from the inner angle near the base; ovules in pairs, collateral, erect, straight, with the foramen at the opposite extremity from the hilum (*id est*, orthotropus). Fruit of five coriaceous, pyriform, indehiscent carpels. Seeds solitary, uncinate, attached to the base of the carpels; albumen none. Embryo of the same shape as the seed; radicle as long as the cotyledons, at the opposite end from the hilum; cotyledons oblong, fleshy, incumbent. Sea side shrubs. Leaves simple, oblong-spatulate, thickish, pubescent, crowded at the apices of the branches, exstipulate. Flowers yellow, bracteate, somewhat terminal. Suriana, the sole genus, is represented in Florida by S. maritima.

Order 135. Paronychiaceæ, the Knotwort Family. Sepals four to five, distinct or cohering. Petals perigynous, between the divisions of the calyx, usually inconspicuous, sometimes 0. Stamens usually perigynous, sometimes hypogynous, opposite to the sepals when equal to them in number, some of them occasionally wanting; filaments distinct, rarely united; anthers bilocular. Ovary superior, with one or more ovules; styles two to three, distinct or combined. Fruit unilocular, either a utricle covered by the calyx, or a three-valved capsule. Seeds either numerous, attached to a free central placenta, or solitary and pendulous from a long funiculus arising from the base of the fruit. Embryo more or less curved, on one side of farinaceous albumen, or surrounding it. Herbaceous or somewhat shrubby plants, with opposite or alternate, sometimes setaceous and clustered leaves, which are either exstipulate or have scarious stipules. Found in barren places in various parts of Europe, Asia, and North America. They have no known properties of importance. The order has been divided into two sections: 1. Illecebreæ, with the embryo lying on one side of the albumen, and stipulate leaves. 2. Scleranthеæ, with a peripherical embryo, and exstipulate leaves. There are twenty-eight known genera, and nearly 120 species. Examples: *Paronychia, Illecebrum, *Polycarpon, Corrigiola, Scleranthus.

Order 136. Portulacaceæ, the Purslane Family. Sepals two, cohering at the base. Petals usually five, rarely wanting, distinct or cohering at the base, sometimes hypogynous. Stamens usually perigynous, variable in number, all fertile, opposite the petals when of the same number; filaments distinct; anthers versatile, bilocular, with longitudinal dehiscence. Ovary free or partially adherent, one-celled, formed by three united carpels; style single or 0; stigmas several. Fruit capsular, one-celled, opening by circumscissile dehiscence, or by three valves, occasionally monospermous or indehiscent. Seeds numerous or definite, or solitary, attached to a central placenta; albumen farinaceous; embryo peripherical; radicle long. Succulent shrubs or herbs, with alternate, seldom opposite, entire, exstipulate leaves, often having hairs in their axils. They are found in various parts of the world, chiefly, however, in South America and at the Cape of Good Hope. They have a great affinity to Caryophyllaceæ, from which they are

chiefly distinguished by their bisepalous calyx, perigynous stamens, and transversely dehiscent capsule. Examples: *Portulaca, Talinum, *Calandrinia, *Claytonia, *Montia, *Calyptridium. These embrace all the North American genera, with twenty-six species. The entire order includes twelve genera, and 184 species.

Order 137. Turneraceæ, the Turnera Family. Calyx with five equal lobes; æstivation imbricated. Petals five, perigynous, equal; æstivation twisted. Stamens five, perigynous, alternating with the petals; filaments distinct; anthers dithecal, innate, oblong. Ovary free, one-celled, with three parietal placentas; ovules ∞, anatropal; style more or less cohering, or forked; stigmas multifid. Fruit a one-celled, three-valved capsule, dehiscing only half way down, in a loculicidal manner. Seeds crustaceous, reticulated, arillate on one side; embryo slightly curved, in the midst of fleshy albumen; cotyledons plano-convex; radicle pointing to the hilum. Herbaceous or somewhat shrubby plants, occasionally with stellate pubescence, having alternate, exstipulate leaves, and frequently two glands at the apex of the petiole. They are natives of the West Indies and South America. They are not put to any important use. Lindley gives two genera, including sixty species. Examples: *Turnera, Piriqueta. Turnera cistoides, a Florida species, is our sole representative.

Order 138. Passifloraceæ, the Passion-flower Family. Sepals five, combined below into a more or less elongated tube. Petals five, perigynous, often with filamentous or annular processes on their inside, which appear to be an altered whorl or whorls of petals, occasionally wanting, imbricated in æstivation. Stamens five, monadelphous, surrounding the gynophore when present, rarely ∞, usually with processes from the thalamus, interposed between them and the petals; anthers dithecal, extrorse, versatile, dehiscing longitudinally; pollen grains sometimes bursting by opercula. Ovary one-celled, often with a gynophore; ovules anatropal, ∞; styles three; stigmas dilated. Fruit often stipulate, one-celled, sometimes three-valved, opening by loculicidal dehiscence, or succulent and indehiscent. Seeds ∞, attached to parietal placentas, arillate, or strophiolate; spermoderm brittle and sculptured; embryo straight in the midst of this fleshy albumen; radicle pointing to the hilum. Herbs or shrubs, often climbing, with alternate, stipulate or exstipulate leaves. The order has been divided into three sub-orders.

Sub-order 1. *Paropsieæ,* plants not climbing, with a sessile ovary, arillate seeds, and exstipulate leaves.

Sub-order 2. *Passifloreæ,* climbing plants with a stalked ovary, arillate seeds, stipulate leaves, and glandular petioles.

Sub-order 3. *Malesherbieæ,* plants not climbing, with a stalked ovary, style below the apex of the ovary, strophiolate seeds, and exstipulate leaves. They are natives chiefly of warm climates, and are found in America, the East and West Indies. There are fourteen known genera, and 215 species. Examples: Paropsia, Smeathmannia, *Passiflora, Tacsonia, Malesherbia. Passiflora with four species represents this order in North America.

The name passion-flower was given on account of a fancied resemblance to the appearances presented on Mount Calvary. In the five anthers, a

resemblance was seen to the wounds of Christ; the triple style represented the three nails on the cross; the central gynophore was the pillar of the cross; and the filamentous processes, the rays of light around the Savior's head, or the crown of thorns. Some species, as Passiflora edulis or Grenadilla, yield a pleasant fruit.

ORDER 139. BELVISIACEÆ, the Belvisia Family. Calyx gamosepalous, persistent, limb divided into five thick ovate segments; æstivation valvate. Petals inserted in the tube of the calyx, united more or less, and forming three verticils, the innermost of which may be considered as an altered staminal row; the outer petaline verticil consists of five plaited lobes, each of which is seven-toothed, and has seven feathered ribs; the second petaline verticil is cut into a number of narrow segments; while the third is an inconspicuous cup-like ring, with its edge minutely divided. Stamens ∞, united at their base so as to be monadelphous, or unequally polyadelphous; filaments curved inwards; anthers dithecal, oblong. Ovary surrounded by a fleshy disk, and adherent to the tube of the calyx, five-celled; ovules two in each cell, attached to a central placenta, nucleus curved; style five-angled; stigma broad, flat, pentagonal. Fruit a large, fleshy, rounded berry, crowned by the lobes of the calyx. Seeds large, kidney-shaped; cotyledons plano-convex; radicle and plumule immersed in their substance. Shrubs, with alternate, simple, coriaceous, exstipulate leaves; and axillary flowers often in sets of three. They are tropical, chiefly African. Some of them are used as astringents. Their place in the natural system is not well determined; some placing the order next Passifloraceæ, others near Symplocaceæ, and Lindley recognising its affinity to Rhizophoraceæ. There are two genera, and four species. Ex.: Belvisia (Napoleona), Asteranthos.

ORDER 140. PAPAYACEÆ, the Carica Family. Calyx minute, five-toothed. Corolla monopetalous, inserted into the base of the calyx; in the male, tubular and five-lobed; in the female, divided nearly to the base into five segments. In the section Pangieæ the sepals and petals are distinct. Stamens ten, inserted into the throat of the corolla; anthers bilocular, introrse, innate, dehiscing longitudinally. Ovary free, one-celled; ovules indefinite, attached to five parietal placentas; stigma five-lobed, lacerated. Fruit usually succulent and indehiscent, sometimes capsular and dehiscent, one-celled. Seeds ∞, enveloped in a loose mucous coat, parietal; spermoderm brittle, pitted; embryo in the axis of fleshy albumen; cotyledons flat; radicle slender, turned towards the hilum. Trees or shrubs, not branching, with alternate lobed leaves, supported on long slender petioles, and with unisexual flowers. They are found in South America and in other warm countries. One of the most important plants of the order is Carica papaya, the Papaw tree, which yields an acrid milky juice, and an edible fruit. The tree is said to have the property of rendering meat tender. The order has been divided into three sections: 1. Cariceæ, corolla monopetalous, fruit succulent and indehiscent. 2. Modecceæ, corolla monopetalous, fruit capsular and dehiscent. 3. Pangieæ, corolla polypetalous. There are eleven known genera, including twenty-nine species. Examples: Carica, Modecca, Pangium.

Carica papaya, the West Indian Papaw (*pl.* 71, *fig.* 14); *a*, the tree with the fruit; *b*, male flower; *c*, section of do.; *d*, stamen; *e*, abortive pistil of the male flower; *f*, a female flower; *g*, pistil; *h*, cross-section of the fruit; *i*, a seed; *k*, partial section of do.; *l*, embryo.

ORDER 141. CUCURBITACEÆ, the Cucumber Family. Calyx five- (rarely six-) toothed; the limb sometimes obsolete. Petals five (rarely six), distinct, or commonly more or less united with each other and coherent with the calyx, very cellular and often marked with reticulated veins. Stamens five, sometimes distinct, commonly united in three parcels (two and two, and one separate) so as to appear like three stamens only, rarely three and diadelphous; filaments of each set sometimes connate; anthers usually long and sinuous, or variously contorted or folded, two-celled, adnate, extrorse, commonly more or less connate. Ovary coherent with the tube of the calyx, usually of three (rarely of two or four) united carpels, sometimes one-celled by the obliteration of the partitions, or often with each carpel spuriously two-celled by the introflexion of the placenta from the axis until it reaches the dorsal suture. Fruit fleshy or juicy, rarely membranous, usually a pepo. Seeds anatropous, compressed, often enveloped by a juicy or dry and membranous arillus; the testa coriaceous; albumen none. Embryo straight; cotyledons foliaceous, palmately veined. Herbs with succulent stems, climbing by means of tendrils (which are transformed stipules, according to St. Hilaire). Leaves alternate, palmately veined. Flowers axillary, monœcious or diœcious, or rarely perfect.

Sub-order 1. *Nandirhobeæ.* Tendrils axillar. Three distinct styles. Three hollow cells, with many seeds ascending from the base. Example: Fevillea.

Sub-order 2. *Cucurbiteæ.* Tendrils lateral. Styles united. Cells full, with a parietal insertion of the seeds. Section 1. Coniandreæ. Example: Coniandre. Section 2. Melothrieæ. Example: *Melothria. Section 3. Bryonieæ. Examples: *Bryonia, Citrullus, *Momordica, *Lagenaria. Section 4. Cucumerineæ. Examples: Cucumis, Cucurbita. Section 5. Telfaireæ. Example: Telfairia. Section 6. Cyclanthereæ. Example: Cyclanthera.

Sub-order 3. *Sicyoideæ.* Tendrils lateral. A single cell with a single ovule suspended from the summit. Example: *Sicyos.

Some of the plants of this order are medicinal, others afford a pleasant fruit. Cucurbita citrullus is the water-melon. The pulp of the fruit of Citrullus colocynthis is known in the pharmacopœia as colocynth. The calibash or bottle gourd is the fruit of Lagenaria vulgaris. Elaterin is the active principle contained in the fruit of Momordica elaterium, or squirting cucumber. The cucumber, the pumpkin, the squash, and the vegetable marrow all belong to this order. There are about sixty-six genera, with three hundred species in all, of which seven genera and nine species belong to North America.

Cucumis citrullus, Water-melon (Asia) (*pl.* 71, *fig.* 11); *a*, flowering branch; *b*, flower; *c–d*, stamens; *e*, stigma; *f*, cross-section of fruit; *g–i*, embryo.

Momordica balsaminea, Balsam apple (East Indies) (*pl.* 71, *fig.* 12); *a*, branch with flowers and fruit; *b*, male flower; *c*, do. without corolla; *d*, female flower; *e*, cross-section of the young fruit; *f*, the fruit burst open; *g*, a seed; *h*, do. without the testa; *i*, cross-section of do.

Bryonia alba (Europe) (*pl.* 71, *fig.* 13); A, branch with male, B, do. with female flowers; C, root; *a*, male flower; *b*, do. expanded; *c–d*, stamens; *e*, female flower; *f*, do. with the corolla cut away; *g*, stigma; *h*, fruit; *i*, cross-section of do.; *k*, seed.

Order 142. Loasaceæ, the Chili Nettle Family. Calyx four- or five-parted, persistent, spreading in æstivation. Petals five, cucullate, epigynous, alternate with the segments of the calyx, sometimes with an inner row of five, which are either similar to the outer or dissimilar; æstivation inflexed, valvate, or twisted. Stamens ∞ in several rows, distinct, or polyadelphous, each parcel being opposite the outer petals; filaments subulate, unequal, the outer ones often sterile. Ovary inferior, one-celled, with parietal placentas; ovules anatropal; styles combined into one; stigma one or several. Fruit capsular, or succulent, one-celled. Seeds without an arillus; embryo straight, in the axis of fleshy albumen; cotyledons small, flat; embryo pointing to the hilum. Herbaceous plants, hispid with stinging hairs, having opposite or alternate exstipulate leaves, and axillary one-flowered peduncles. They are American plants, chiefly distinguished for their stinging qualities, and hence the name of Chili Nettle. There are fifteen genera enumerated by Lindley, including seventy species. Examples: Loasa, *Mentzelia, Gronovia, *Cevallia. In North America there are of this order, Mentzelia with twelve, and Cevallia with one species.

Order 143. Haloragaceæ, the Mares-tail Family. Calyx with a minute limb, which is either three- or four-divided or entire; it is sometimes reduced to a mere rim. Petals epigynous or 0. Stamens epigynous, equal in number to the petals, or twice as many, rarely fewer; when the petals are wanting, stamens often one or two. Ovary cohering with the tube of the calyx, with one or more cells, sometimes tetragonal or compressed Style 0, what is frequently called the styles being the papulose stigmas, which are equal in number to the cells; ovules pendulous, anatropal. Fruit dry, indehiscent, membranous or bony, with one or more cells. Seed solitary or in pairs, pendulous; albumen fleshy or thin; embryo straight, or slightly curved, in the axis of the albumen; cotyledons minute; radicle superior, long. Herbs, or undershrubs, often aquatic, with large air cavities, having alternate, opposite, or whorled leaves, and axillary, sessile flowers, which are occasionally unisexual. They are found in ditches and lakes in various parts of the world. They have no properties of importance. There are eight known genera, and about seventy species. Examples: *Hippuris, Myriophyllum, Haloragis, Callitriche, *Proserpinaca. North American species twelve.

Order 144. Onagraceæ, the Evening Primrose Family. Calyx tubular, the limb having usually four, sometimes two, three, or six divisions, which cohere in various ways; æstivation valvate. Petals usually equal in number to the calycine segments, regular (rarely irregular), inserted into

the tube of the calyx, æstivation twisted. Stamens usually four or eight (rarely one or two), epigynous; filaments distinct; pollen triangular, usually cohering by threads. Ovary two- to four-celled, adherent, usually with an epigynous disk; style filiform; stigma capitate or four-lobed; ovules indefinite, rarely definite, anatropal. Fruit succulent or capsular, dehiscent or indehiscent, one,- two,- to four-celled. Seeds usually ∞, exalbuminous; embryo straight, with a long slender radicle pointing to the hilum, and short cotyledons. Herbs or shrubs, with alternate or opposite, simple, not dotted leaves, and with the parts of the flower usually tetranerous. They inhabit chiefly temperate regions, and are found abundantly in Europe, Asia, and America, and sparingly in Africa.

Tribe 1. *Jussieueæ.* Calyx divided immediately above the ovary. Number of stamens equal to, or double that of the petals. Fruit capsular, with septicidal dehiscence, many seeded. Cotyledons straight. Examples: *Jussieua, *Ludwigia.

Tribe 2. *Onagreæ.* Calyx with the tube more or less elongated. Number of stamens double that of petals. Fruit capsular with loculicidal dehiscence, many seeded. Cotyledons straight. Examples: *Oenothera, *Gayophytum, *Epilobium.

Tribe 3. *Gaureæ.* Calyx with the tube elongated. Number of stamens double that of petals. Fruit indehiscent, nucumentaceous, one- to four-seeded. Cotyledons twisted. Examples: *Gaura, *Stenosiphon.

Tribe 4. *Fuchsieæ.* Calyx with the tube elongated. Number of stamens double that of petals. Fruit fleshy. Cotyledons straight. Example: Fuchsia.

Tribe 5. *Lopezieæ.* Tube of calyx elongated. Petals four or more. Stamens two or one. Fruit capsular, many seeded, with loculicidal dehiscence. Example: Lopezia.

Tribe 6. *Circaeæ.* Calyx divided into two segments immediately above the ovary: petals two; stamens two. Fruit indehiscent, two-locular, two-seeded. Examples: Circæa.

Of the above order there are about 30 genera and 450 species. North America has 12 genera and 117 species. Among the more prominent species is Oenothera biennis, the Evening Primrose.

Oenothera biennis, Evening Primrose, United States (*pl.* 69, *fig.* 6); *a*, a flowering branch; *b*, calyx; *c*, stamen; *d*, vertical section of calyx tube; *e*, burst capsule; *f*, cross-section of do.; *g*, seed.

Epilobium angustifolium, Willow-herb (Europe) (*pl.* 69, *fig.* 7); *a*, a flower branch; *b*, calyx with style and a stamen; *c*, burst capsule; *d*, a seed.

Order 145. Myrtaceæ, the Myrtle Family. Calyx four-, five-, six- to eight-cleft, the limb sometimes cohering at the apex, and falling off like a lid; æstivation valvate. Petals attached to the calyx, alternating with its segments, and equal to them in number, with a quincuncial æstivation, rarely 0. Stamens inserted with the petals, twice as many as the petals, or ∞; filaments distinct, or united in one or more parcels, curved inwards in the bud; anthers ovate, dithecal, with longitudinal dehiscence. Ovary adherent to the tube of the calyx, one- to six-celled; style and stigma

simple; ovules anatropal, pendulous, or erect. Fruit dry or fleshy, dehiscent or indehiscent. Seeds usually ∞, attached to a central placenta; mostly exalbuminous; embryo straight or curved; cotyledons distinct, or consolidated with the radicle, which is next the hilum. Trees or shrubs, with opposite, rarely alternate leaves, which are usually entire and dotted, and frequently have an intramarginal vein. They are natives chiefly of warm countries, as South America and the East Indies. Many, however, are found in more temperate regions. Some of the genera are peculiar to Australia. The order has been divided into the following sub-orders:

Sub-order 1. *Chamælaucieæ,* heath-like plants, with a one-celled ovary and capsule, and opposite dotted leaves.

Sub-order 2. *Leptospermeæ,* having a plurilocular capsule, and opposite and alternate, usually dotted leaves.

Sub-order 3. *Myrteæ,* having a baccate fruit, distinct stamens, opposite dotted leaves.

Sub-order 4. *Barringtonieæ,* having a fleshy, one-celled fruit, monadelphous stamens, albuminous seeds, opposite or verticillate leaves, not dotted.

Sub-order 5. *Lecythideæ,* having a plurilocular woody capsule, which either remains closed or opens by a lid, monadelphous stamens, alternate, not dotted leaves.

Several of these sub-orders are made separate orders by Lindley and others. There are 77 known genera, and upwards of 1400 species. Examples: Chamælaucium, Calytrix, Leptospermum, Melaleuca, Metrosideros, Eucalyptus, Myrtus, Psidium, Eugenia, Caryophyllus, Barringtonia, Gustavia, Lecythis, Bertholletia. No species has yet been described from North America, although some probably are to be found in Florida.

Those plants of this order, with pellucid dots in the leaves, yield a volatile oil. Some furnish edible fruits. The clove of commerce is the flower-bud of Caryophyllus aromaticus, originally from the Moluccas. Allspice, or Pimento, is the dried berry of Eugenia pimenta, indigenous to the West Indies and to Mexico. Psidium pyriferum yields the guava. Punica granatum, the Pomegranate, is a well known ornamental species. Cream or Brazil nuts are derived from Bertholletia excelsa. Sugar from Eucalyptus, natives of New Holland, has recently excited the attention of chemists. Cajeput oil is derived from species of Melaleuca.

Caryophyllus aromaticus, the Clove Tree (*pl.* 69, *fig.* 12); *a,* flowering branch; *b,* flowers without; *c,* ditto with stamens; *d,* anther; *e,* calyx; *f, g,* buds; *h–k,* fruit; *l–n,* the seed.

Melaleuca cajeput, the Cajeput Tree, Borneo, &c. (*pl.* 69, *fig.* 9); *a,* a flowering branch; *b,* flower in vertical section; *c,* calyx; *d, e,* fruit.

Melaleuca fulgens, New Holland (*pl.* 69, *fig.* 10); *a,* a bundle of filaments, with three petals and the pistil; *b,* pistil.

Eugenia pimenta, Allspice, West Indies (*pl.* 69, *fig.* 11); *a,* a flower; *b,* ditto magnified; *c,* calyx with pistil; *d,* pistil with stamens; *e* and *g,* berries; *f,* a twig with berries; *h,* vertical section; *i–k,* seeds.

Order 146. Melastomaceæ, the Melastoma Family. Calyx with four, five, or six divisions, which are more or less deep, or are sometimes united

and separate from the tube like a lid. Petals equal to the segments of the calyx, perigynous, æstivation twisted. Stamens equal in number to the petals, and alternate with them, usually with intermediate sterile ones; filaments curved downwards in the young state; anthers long, often beaked, bilocular, dehiscing by two terminal pores, or longitudinally. Ovary more or less adherent to the calyx, plurilocular; ovules usually 00; style one: stigma simple, either capitate or minute. Fruit plurilocular, either capsular, with loculicidal dehiscence, or succulent, combined with the calyx and indehiscent. Seeds ∞, minute, attached to central placentas, exalbuminous; embryo, straight or curved; cotyledons sometimes unequal, flat, or convolute. Trees, shrubs, or herbs, with opposite, undivided, usually entire, often three- to nine-ribbed leaves, not dotted. They are found chiefly in warm climates. Many are natives of America and India. There are no unwholesome plants in the order, and the succulent fruit of several species is edible. A slight degree of astringency pervades all the plants of the order, and hence some are used medicinally, in cases of diarrhœa. The name Melastoma is derived from the circumstance that the fruit of some dyes the lips black.

Tribe 1. *Lavoisierieæ.* Anthers opening by one or two pores. Ovary free, usually smooth at the summit. Fruit capsular. Seeds straight, ovoid, or angular. Species all American (none in North America). Example: Meriania.

Tribe 2. *Rhexieæ.* Anthers opening by a single pore. Ovary free, usually smooth at the summit. Fruit capsular. Seeds reniform. Species all American (Rhexia, with eight species, the only North American). Example: *Rhexia.

Tribe 3. *Osbeckieæ.* Anthers opening by a single pore. Ovary free or adherent, usually surmounted by setæ, or scales. Fruit capsular or fleshy. Seeds reniform. Old and New World. Example: Osbeckia.

Tribe 4. *Miconieæ.* Anthers opening by one or two pores. Ovary adherent. Fruit fleshy. Seeds straight. Plants mostly American. Example: Cidemia.

Tribe 5. *Charianthеæ.* Anthers opening by longitudinal slits. Ovary adherent. Fruit generally fleshy. Seeds straight. Plants American or Asiatic. Example: Astronia.

Lindley gives 118 genera and 1200 species as belonging to this order.

Melastoma malabathricum, Malabar (*pl.* 69, *fig.* 13).

Order 147. Combretaceæ, the Myrobalan Family. Calyx four- or five-lobed, lobes deciduous. Petals arising from the orifice of the calyx, alternate with the lobes, or wanting. Stamens epigynous, twice as many as the lobes of the calyx, rarely equal in number, or thrice as many; filaments distinct, subulate; anthers dithecal, dehiscing longitudinally, or by recurved valves. Ovary adherent to the tube of the calyx, unilocular; ovules two to four, pendulous; style one; stigma simple. Fruit succulent or nut-like, inferior, unilocular, indehiscent, often winged. Seed solitary, pendulous, exalbuminous; cotyledons leafy, usually convolute, sometimes plicate; radicle turned towards the hilum. Trees or shrubs, with alternate

or opposite, exstipulate, entire leaves. They are natives of the tropical regions of Asia, Africa, and America. The general property of the order is astringency. Many are used for tanning, and some for dying. The fruit of Terminalia belerica, and of T. chebula, under the name of Myrobalans, is used as an astringent. The seeds of Terminalia catappa are eaten like almonds. The order has been divided into three sub-orders :

Sub-order 1. *Terminalieæ*, petals 0, cotyledons convolute.

Sub-order 2. *Combreteæ*, petals present, cotyledons plicate.

Sub-order 3. *Gyrocarpeæ*, petals 0, cotyledons convolute, anthers dehiscing by recurved valves.

There are 22 genera enumerated by Lindley, including 200 species. Examples : *Terminalia, Combretum, Gyrocarpus, *Conocarpus. The order is represented in Florida by Conocarpus erecta, and Terminalia catappa.

Order 148. Vochysiaceæ, the Vochysia Family. Sepals four to five, united at the base, unequal, the upper one largest and spurred ; æstivation imbricated. Petals one, two, three, or five, alternate with the divisions of the calyx, and inserted into its base, unequal. Stamens one to five, opposite to, or alternate with the petals, perigynous, one having an ovate, fertile, four-celled anther, the rest being sterile. Ovary free, or partially adherent to the calyx, three-celled ; ovules solitary or in pairs, rarely numerous, amphitropal or anatropal ; style and stigma one. Fruit a triquetrous, three-celled and three-valved capsule, usually with loculicidal dehiscence. Seeds usually one to two in each cell, erect, exalbuminous, attached to a central placenta ; embryo straight ; cotyledons large and leafy ; radicle short and superior. Trees or shrubs, with opposite, entire, exstipulate leaves. They inhabit the warmer parts of America. Their properties are little known. There are eight genera enumerated, including fifty-one species. Examples: Vochysia, Qualea.

Order 149. Rhizophoraceæ, the Mangrove Family. Calyx adherent, four- to twelve-lobed ; æstivation valvate, or sometimes calyptriform. Petals arising from the calyx, alternate with the lobes, and equal to them in number. Stamens inserted with the petals, twice or thrice their number ; filaments distinct, subulate ; anthers erect. Ovary two-, three-, to four-celled ; ovules two or more in each cell, anatropal. Fruit indehiscent, adherent to the calyx, and crowned by it, unilocular, monospermous. Seed solitary, pendulous, exalbuminous ; cotyledons flat ; radicle long, piercing the fruit. Trees or shrubs, with simple opposite leaves, and deciduous interpetiolary stipules. They are found on the muddy shores of the tropics. There are five genera, and twenty species known. Examples : *Rhizophora, Kandelia.

Rhizophora mangle or the Mangrove, forms thickets along the muddy shores of the ocean in Florida, sending out adventitious shoots. The embryo germinates while still within the pericarp.

Order 150. Lythraceæ, the Willow Strife Family. Calyx tubular, lobed, the lobes sometimes with intermediate lobes or teeth, æstivation valvate. Petals alternate with the primary lobes of the calyx, very deciduous, sometimes 0. Stamens inserted into the tube of the calyx a

little below the petals, equal in number to them, or two, three, or four times as many; anthers adnate, dithecal, introrse, with longitudinal dehiscence. Ovary superior, two- to six-celled; ovules numerous, anatropal; style filiform; stigma usually capitate. Fruit a dehiscent membranous capsule, surrounded by the calix but not adherent to it, sometimes one-celled by the obliteration of the dissepiments. Seeds numerous, small, apterous or winged, exalbuminous, attached to a central placenta; embryo straight; cotyledons flat and foliaceous; radicle next the hilum. Herbs and shrubs, with branches which are usually tetragonal, and with opposite, rarely alternate, entire, exstipulate leaves without glands. They are natives of Europe, North and South America, and India. The order is divided into two sub-orders:

Sub-order 1. *Lythreæ*, with apterous (wingless) seeds.

Sub-order 2. *Lagerströmieæ*, with winged seeds.

Lindley gives thirty-five genera, including three hundred species. Examples: *Lythrum, *Cuphea, Lagerströmia.

Lythrum salicaria, the Willow Strife, is found in all quarters of the globe. Lawsonia inermis furnishes the Henna of the Arabians, a substance used in imparting an orange color. North American genera five, with ten species.

Lythrum salicaria (*pl.* 70, *fig.* 1); A, lower part; B, upper part; *a*, portion of flower displayed; *b*, an anther; *c–e*, fruit; *f–g*, seed.

ORDER 151. CALYCANTHACEÆ, the Calycanthus Family. Sepals and petals confounded, indefinite, combined in a fleshy tube; æstivation imbricated. Stamens ∞, perigynous; anthers adnate, extrorse, with longitudinal dehiscence. Ovaries several, one-celled, adhering to the tube of the calyx; ovules solitary or two, one above the other, anatropal; style terminal. Fruit consisting of achænia, inclosed in the fleshy tube of the calyx. Seed exalbuminous; embryo straight; cotyledons convolute; radicle inferior. Shrubs, with square stems, consisting of a central woody mass, with four smaller ones around; leaves opposite, simple, scabrous, exstipulate. They are natives of North America and Japan.

The genera are *Calycanthus and Chimonanthus, with six species. Calycanthus *floridus is the so-called shrub of gardens, well known for the sweet scented flowers called Shrubs. A second species is found in California.

ORDER 152. ROSACEÆ, the Rose Family. Calyx four- to five-lobed, the fifth lobe superior. Petals as many as the divisions of the calyx, often five, sometimes wanting, perigynous, generally regular; æstivation quincuncial. Stamens inserted with the petals, definite or indefinite; filaments incurved in æstivation; anthers bilocular, dehiscing longitudinally. Ovaries superior, either solitary or several, unilocular, sometimes uniting so as to form a many-celled pistil; ovules one, two, or more, anatropal, suspended, rarely erect; styles lateral; stigmas usually simple. Fruit either achænia or drupes, or follicles or pomes. Seeds erect or inverted, usually exalbuminous; embryo straight, with the radicle next the hilum, and leafy or fleshy cotyledons. Herbaceous plants, or shrubs, or trees, with simple or

compound, alternate, stipulate leaves, and the flowers sometimes unisexual. They are found chiefly in the cold and temperate climates of the northern hemisphere. Some are found on high mountains within the tropics, and a few occur in warm regions.

Sub-order 1. *Pomeæ.* Calyx campanulate or urceolate, more or less globose in fruit, when it becomes extremely thick and juicy, including and cohering with the ovaries. Ovaries two to five, or sometimes solitary, mostly coherent with each other, with two collateral ascending ovules; styles terminal, sometimes coherent; stigma simple or emarginate. Fruit a pome one- to five-celled; the cells sometimes spuriously divided by the inflexion of the dorsal suture. Seeds one to two in each carpel (many in Cydonia). Trees or shrubs (confined to temperate climates), with simple or sometimes pinnate leaves, which, except in Cotoneaster, do not contain hydrocyanic acid. Fruit usually eatable. Examples: *Pyrus, Cydonia, *Amelanchier, *Cratægus, *Photinia, *Peraphyllum, &c. This sub-order includes some of our most important fruit, as the apple, the pear, &c. All the cultivated varieties of apple are derived from Pyrus malus, those of the pear from P. communis. The principal North American species is P. coronaria, the wild crab apple, a small tree with very fragrant flowers. The different thorns mostly belong to Cratægus, of which North America has seventeen species. The Service or June berry, Amelanchier canadensis, blooms early in spring before the leaves put out, and at a distance looks like a mass of snow. Cydonia vulgaris, the Quince, was originally a native of Crete.

Sub-order 2. *Rosaceæ* proper. *Tribe* 1. *Roseæ.* Calyx urceolate; the tube contracted at the mouth, at length fleshy or baccate, including the numerous distinct ovaries: the segments somewhat spirally imbricated in æstivation. Carpels (achænia) one-seeded and indehiscent, crustaceous, hairy, with two suspended ovules, one above the other, inserted on the whole inner surface of the thickened torus or disk which lines the tube of the calyx; styles terminal or nearly so, somewhat exserted, distinct, or connate above, rather persistent. Shrubby and prickly plants, with pinnate leaves, rarely reduced to a single leaflet, and mostly adnate stipules. Examples: *Rosa, Hultemia, Lowea. The principal genus in this sub-order is Rosa, which includes the various species of Rose. Of the genus there are eleven species and upwards, native to North America. The varieties of Scotch roses are derived from R. spinosissima; those of the dog-rose from R. canina. The cabbage rose, R. centifolia, with its varieties, R. damascena, the Damask rose, R. moschata, the musk-rose, &c., are used in the preparation of Rose water and Otto of Roses. It is said that 100,000 roses, the produce of 10,000 bushels of Rosa damascena, yield but 180 grains of the attar or otto.

Tribe 2. *Neureadeæ.* Calyx united to the carpels, the tube short, the limb divided into five lobes. Petals five. Stamens twice this number. Ten carpels coherent with the calyx, each containing suspended, an ovule; surrounded by five to ten styles; separating at maturity by their anterior face, which opens by the corresponding suture, remaining attached by the

back to the tube of the calyx. The species are all from temperate North and South Africa, herbaceous, with leaves once or twice pinnatifid. Examples: Neurada, Grielum.

Tribe 3. *Dryadeæ.* Divisions of the calyx five, rarely four or more, the æstivation usually valvate, often doubled by an exterior calicle produced by the coherence of the calycinal stipules. Petals of the same number with the divisions of the calyx, sometimes 0. Stamens definite or indefinite. Carpels often numerous, sometimes reduced in number, borne on a central, more or less projecting, receptacle; free, with a terminal style, or more frequently lateral, each containing one or two ovules, upright or suspended, and subsequently a like number of dry or fleshy achænia. Trees or shrubs, with leaves compound, digitate or pinnate, rarely simple. Inhabitants of temperate regions for the most part; some found at great elevations.

Sub-tribe 1. *Dalibardeæ.* No calicle. Stamens indefinite. Carpels numerous, with the styles terminal. Radicle superior. Examples: *Dalibarda, *Rubus. The latter genus includes the various species of Raspberry and Blackberry, of which there are twenty-three North American species.

Sub-tribe 2. *Fragarieæ.* Calyx calicled, with valvate æstivation. Stamens indefinite. Carpels numerous, with the styles lateral. Radicle superior. Examples: *Fragaria, *Potentilla. The former genus includes the Strawberries, of which two species are indigenous to the United States. One of these is F. vesca, the cultivated species, introduced into gardens, from Europe, nevertheless wild in the Northern States. The other is F. virginiana, the common wild strawberry. The two are readily distinguished by the fruit. The latter has the achænia ("seeds") completely embedded in the deeply-pitted pulp; in the former they stand out.

Sub-tribe 3. *Chamærhodeæ.* Calyx, with or without calicle, æstivation valvate. Stamens five to ten. Number of carpels the same, or a little greater, the styles nearly or quite lateral. Radicle superior. Examples: *Horkelia, *Sibbaldia, *Chamærhodos.

Sub-tribe 4. *Sanguisorbeæ.* Calyx with valvate or imbricate æstivation, with or without calicle, hardening and closing above the ripe carpel. Corolla mostly none. Stamens one to fifteen. Carpels two, rarely more. Styles terminal or lateral. Radicle superior. Examples: *Agrimonia, *Sanguisorbia.

Sub-tribe 5. *Cercocarpeæ.* Calyx without a calicle, æstivation imbricated. Petals five or 0. Stamens numerous. Carpel single, with the style terminal. Radicle inferior. Examples: *Cercocarpus, *Purshia.

Sub-tribe 6. *Eudryadeæ.* Calyx with valvate æstivation, with or without calicle. Stamens numerous. Carpels numerous, with the styles terminal. Radicle inferior. Examples: *Geum, *Dryas, *Waldsteinia.

Tribe 4. *Spiræaceæ.* Limb of the calyx with five divisions, more or less deep, æstivation imbricate, more rarely valvate. Petals of the same number. Stamens indefinite. Carpels five, more rarely reduced to two, and even one, free, verticillate, styles usually terminal, containing one, two, or more ovules, suspended or ascending, becoming of the same number of

follicles. Trees or shrubs, more rarely herbs, with simple or compound leaves; the flowers white, yellow, or red, solitary or grouped in definite or indefinite inflorescence. They contain astringent principles, together with resin and volatile oil.

Sub-tribe 1. *Spireæ.* Seeds not winged. Inhabitants of the northern hemisphere, north of the tropic of Cancer. Examples: *Spiræa, *Gillenia, *Nuttalia.

Sub-tribe 2. *Quiltajeæ.* Seeds winged. Inhabitants of tropical and South America. Example: Lindleya.

Sub-order 3. *Amygdaleæ.* Calyx five-partite, with imbricate æstivation. Petals five. Stamens numerous or indefinite. Carpel single, with style entirely or nearly terminal, containing two suspended collateral ovules, becoming one drupe. Seed with a membranaceous integument. Trees and shrubs, with the branches sometimes spined; leaves simple, often bi-glandular; flowers white or rose colored, disposed in racemes, corymbs, or panicles, often developed before the leaves. Most of the species natives of the north temperate zone, some inhabit Asia or tropical America, none found in the southern hemisphere beyond the tropics. Many of the species generally distributed by cultivation. The bark yields gum; the leaves, bark, and the kernels of many species contain hydrocyanic acid. Examples: Pygeum, Amygdalus, Persica, *Prunus. Amygdalus communis, the Almond tree, grows native in Barbary and Eastern Asia. Of two principal varieties, one (dulcis) furnishes the Sweet and the other (amara) the Bitter almond. Sweet Almonds come from Valencia and Malaga, Bitter from Mogadore. The Peach (Persica vulgaris), a native of Persia, has fruit of two kinds, Freestone and Clingstone; in the latter the pulp is adherent to the stone when ripe. The Apricot, Armeriaca vulgaris, is also Asiatic. Prunus domestica furnishes the different varieties of plum, one of which, when dried, occurs in commerce as prunes. Several species of plum are indigenous to the United States. The leaves of P. spinosa, the Sloe, are used to adulterate tea. Cherries are the fruit of Prunus (Cerasus) avium. The poisonous laurel of Europe is P. (Cerasus) laurocerasus.

Sub-order 4. *Chrysobalaneæ.* Calyx free from the ovary, or cohering on one side with its base. Petals and the (somewhat definite or indefinite) stamens more or less irregular in size and position. Ovary solitary, with two collateral, erect ovules, the style arising from its base. Fruit a drupe. Seed with a membranous integument. Trees or shrubs with simple, glandless, entire leaves; flowers more or less irregular in racemes or corymbs. Mostly natives of tropical America and Africa, rare in Asia. Example: *Chrysobalanus. The fruit of C. icaco is the Cocoa plum of Florida and the West Indies.

The entire order embraces about 82 genera and 1000 species, of which 30 genera and about 200 species are North American.

Potentilla anserina, Silver Weed, Europe and N. America (*pl.* 70, *fig.* 4); *a*, the plant; *b*, the flower; *c*, calyx with the sexual apparatus; *d*, calyx from beneath; *e*, anther.

Rosa moschata, Musk Rose, North Africa and South Asia (*pl.* 70, *fig.* 3).

Mespilus germanica, Medlar (*pl.* 70, *fig.* 2); *a*, a flowering branch; *b*, fruit; *c*, seed.

Amygdalus communis (var. dulcis), Sweet Almond (*pl.* 70, *fig.* 5); A, branch with flowers; B, ditto with fruit; *a*, flower; *b*, calyx; *c*, petal; *d*, pistil; *e*, fruit with the hull in vertical section; *f*, nut; *g*, *h*, seed or kernel; *i*, vertical section; *k*, *l*, bases of leaves.

Order 153. Moringaceæ, the Moringa Family. Calyx five-partite; æstivation slightly imbricated. Petals five, rather unequal, upper one ascending. Stamens eight or ten, perigynous; filaments slightly petaloid, callous, and hairy at the base; anthers simple, one-celled, with a thick convex connective. Disk lining the tube of the calyx. Ovary superior, stipitate, one-celled; ovules anatropal, attached to parietal placentas; style filiform; stigma simple. Fruit a pod-like capsule, one-celled, three-valved, opening by loculicidal dehiscence. Seeds numerous, half buried in the spongy substance of the valves, sometimes winged, exalbuminous; embryo with a superior, straight, small radicle, and fleshy cotyledons. Trees with bi- or tri-pinnate, stipulate leaves, natives of the East Indies and Arabia. Some of them are pungent and aromatic. The seeds of Moringa pterygosperma, Horse-radish tree, are winged, and are called Ben-nuts. From them is procured a fluid oil, used by watch-makers, and called Oil of Ben. The root is pungent and stimulant, and resembles Horse-radish in its taste. Lindley mentions one genus and four species. Example: Moringa.

Order 154. Leguminosæ, the Pea Family. Calyx five-partite, toothed, or cleft, with the odd segment anterior; segments often unequal and variously combined. Petals five, or by abortion four, three, two, one, or 0, inserted into the base of the calyx, sometimes equal, but usually unequal, often papilionaceous, with the odd petal superior. Stamens definite or indefinite, usually perigynous, distinct or monadelphous or diadelphous or rarely triadelphous; anthers bilocular, versatile. Ovary superior, one-celled, consisting usually of a solitary carpel, sometimes of two to five; ovules one or many; style simple, proceeding from the upper or ventral suture; stigma simple. Fruit a legume, or a drupe. Seeds solitary or several, sometimes arillate, often curved; embryo usually exalbuminous, straight, or with the radicle bent upon the edges of the cotyledons, which are either epigeal or hypogeal in germination, and leafy (Phyllolobæ) or fleshy (Sarcolobæ). Herbaceous plants, shrubs, or trees, with alternate, usually compound leaves, having two stipules at the base of the petiole, and two at the base of each leaflet in the pinnate leaves. Pedicels usually articulated. The flowers are frequently papilionaceous, and the fruit is commonly leguminous, and by the presence of one or other of these characters the order may be recognised. The order now embraces 467 genera, and 6500 species, of which North America has about seventy genera, and 450 species.

Sub-order 1. *Papilionaceæ.* Sepals imbricated (or sometimes slightly valvate) in æstivation. Corolla papilionaceous or more or less irregular, rarely wanting. Stamens ten, or occasionally fewer, inserted with the

petals into the bottom of the calyx, or perigynous. Radicle bent back upon the edge of the cotyledons, or straight. Leaves simple or simply compound (in Cassieæ sometimes bipinnate). Flowers usually perfect.

Tribe 1. *Podalyrieæ.* Ten free stamens. Legume bivalve, very rarely indehiscent, and then shorter than the calyx. Cotyledons foliaceous in germination, the radicle curved on their commissure. Leaves one- to three-foliated, very rarely imparipinnate. 1. *Podalyrieæ.* Examples: *Pickeringia, *Scolobus, *Baptisia. 2. *Pulteneæ.* Example: Burtonia. 3. *Mirbelieæ.* Example: Mirbelia.

Tribe 2. *Loteæ.* Ten stamens monadelphous or diadelphous. Legume bivalve, continuous (without articulations). Cotyledons foliaceous in germination, radicle curved. Leaves one-, to three-, or many-foliated, often paripinnate. 1. *Genisteæ.* Examples: Genista, *Lupinus. 2. *Trifolieæ.* Examples: *Trifolium, *Melilotus, Medicago. 3. *Galegeæ.* Examples: *Amorpha, *Glycyrrhiza, *Psoralea, *Indigofera, *Robinia. 4. *Astragaleæ.* Examples: *Astragalus, *Phaca.

Tribe 3. *Vicieæ.* Ten diadelphous stamens. Legume bivalve, continuous. Cotyledons thick, remaining underground in germination, radicle inflexed. Leaves often paripinnate, with the petiole prolonged into a bristle or tendril. Examples: *Vicia, *Lathyrus, Cicer.

Tribe 4. *Hedysareæ.* Ten stamens mon- or di- adelphous. Legume lomentaceous. Cotyledons foliaceous, radicle curved. Leaves one- to three-foliated, or imparipinnate, often stipellate. 1. *Coronilleæ.* Example: Coronilla. 2. *Hedysareæ.* Examples: *Hedysarum, Arachis. 3. *Alhageæ.* Example: Nissolia.

Tribe 5. *Phaseoleæ.* Ten monadelphous stamens. Legume bivalve, continuous, or interrupted by successive constrictions without articulation. Cotyledons thick, hypogean or epigean, radicle curved. Leaves of three leaflets, rarely of many pairs, often stipellate. 1. *Clitorieæ.* Example; *Clitoria. 2. *Kennedyeæ.* Example: Physolobium. 3. *Glycineæ.* Example: *Galactia, Glycine. 4. *Diocleæ.* Example: Bionia. 5. *Erythrineæ*, Examples: Mucunna, *Erythrina. 6. *Wistarieæ.* Examples: *Wistaria, *Apios. 7. *Euphaseoleæ.* Examples: *Phaseolus, *Dolichos, *Vigna. 8. *Cajaneæ.* Example: Fagelia. 9. *Rhynchosieæ.* Examples: *Rhynchosia, *Pitchera. 10. *Abrineæ.* Example: Abrus.

Tribe 6. *Dalbergieæ.* Ten stamens, mon- or di- adelphous. Legume indehiscent, often interrupted by constrictions. Cotyledons thick, fleshy; radicle curved, more rarely straight. Leaves pinnate, leaflets often alternate, more rarely reduced to one. Example: Cyclolobium.

Tribe 7. *Sophoreæ.* Ten, more rarely nine to eight free stamens. Legume indehiscent or bivalve. Cotyledons foliaceous or a little thick; radicle recurved or straight. Leaves imparipinnate or simple. Examples: *Sophora, *Cercis, *Cladrastis.

Many plants of the sub-order Papilionaceæ, have beautiful showy flowers, as Erythrina, Lathyrus, &c. Trifolium pratense, the common red clover, and all the clovers, peas, beans, vetches, &c., belong here. Liquorice is furnished by Glycyrrhiza glabra, a native of southern Europe. Species of

Astragalus yield gum tragacanth. This is especially obtained from A. verus, a native of Persia and Asia Minor. Myroxylon peruiferum furnishes Balsam of Peru; M. toluiferum, Balsam of Tolu. African Kino is produced from Pterocarpus erinaceus. Cowitch consists of the hairs of Mucuna pruriens. Species of Indigofera, as I. tinctoria and cœrulea, yield indigo. Red sandalwood is obtained from Pterocarpus santalinus. Tonga beans are derived from Dipterix odorata. The peculiar flavor of Sapsago cheese is owing to the flowers and seeds of a species of Melilotus. Arachis hypogæa produces its legumes under ground, which are known as ground nuts. Erythrina monosperma yields gumlac. The wood of Robinia pseudo-acacia, or the Locust tree of the United States, is in much request for fence posts, &c., on account of its great durability.

Sub-order 2. *Cæsalpinieæ.* Flowers irregular, but not papilionaceous, petals spreading, imbricated in æstivation, upper one interior. Seeds without albumen, embryo often straight. Stems arborescent or shrubby, sometimes climbing. Leaves simple, or more frequently compound, and often bipinnate.

Tribe 1. *Leptolobieæ.* Calyx usually campanulate, five-fid. Petals five, somewhat unequal. Ten fertile stamens, somewhat unequal, declined or divergent. Support of the ovary free. Leaves pari- or impari- pinnate (not bipinnate); leaflets tending to alternation. Example: Hæmatoxylon.

Tribe 2. *Eucæsalpinieæ.* Calyx five-fid, or more frequently five-partite. Petals five, somewhat unequal. Ten fertile stamens, somewhat declined. Support of the ovary free. Leaves bipinnate. Examples: *Cæsalpinia, *Guilandina, *Gleditschia, *Gymnocladus.

Tribe 3. *Cassieæ.* Calyx five-partite. Petals five. Stamens ten or less, scarcely perigynous, some of them often deformed or wanting. Anthers large, oblong or quadrangular, opening by a pore at the apex, more rarely by a pore at the base. Support of the ovary free. Leaves paripinnate, more rarely with somewhat alternating leaflets, with a terminal one. Examples: *Cassia, Senna.

Tribe 4. *Swartzieæ.* Calyx with valvate dehiscence, sometimes bursting irregularly, sometimes divided to the base in four to five nearly equal segments. Petals five or less; sometimes reduced to one, or entirely absent. Stamens indefinite, more or less numerous, slightly or considerably unequal, inserted with the petals on the receptacle, or else distinctly (but rarely) on the calyx. Leaves imparipinnate; leaflets numerous or solitary. Bractlets mostly wanting. Example: Swartzia.

Tribe 5. *Amherstieæ.* Calyx tubular inferiorly and persistent; divisions four to five, concave, imbricated, reflexed or caducous. Petals five or less, reduced sometimes to one. Stamens ten or more, or less, all, or sometimes one only, very long and folded in the bud. Support of the ovary most generally united on one side with the tube of the calyx. Leaves pari- rarely impari-pinnate. Example: Tamarindus.

Tribe 6. *Bauhinieæ.* Calyx tubular inferiorly, persistent, the divisions sometimes short and dentiform, sometimes elongated and valvate. Petals five. Stamens ten or less. Support of the ovary free or united. Leaves

compound, of a single pair of leaflets, which are distinct, or else united by their borders, more rarely reduced to a single leaflet. Example: Bauhinia.

Tribe 7. *Cynometreæ.* Calyx four- to five-partite, the divisions imbricated, reflexed, or flowering. Petals four to five, nearly equal, more rarely 0. Support of the ovary free, extremely short. Ovule single or double. Leaves compound, of one or more pairs of leaflets often tending to alternation, with or without a terminal leaflet. Example: Copaifera.

Tribe 8. *Dimorphandreæ.* Calyx campanulate, regular, five-toothed. Five petals almost equal. Stamens five, fertile, nearly equal, alternating with an equal number of sterile ones. Leaves singly or doubly pinnate. Example: Mora.

Some species of Cæsalpinieæ have medicinal properties, as the Cassias, from which senna is derived. Tamarindus indicus, or the Tamarind tree, has a fruit with a laxative pulp. Ceratonia siliqua is the carob tree or Locust tree, the fruit of which is supposed to have supplied St. John in the wilderness. The Brazil wood of commerce is derived from Cæsalpinia braziliensis. Hæmatoxylon campeachianum furnishes logwood. Balsam of Copaiva is derived from various species of Copaifera. The seeds of Gymnocladus canadensis or coffee tree of the Western States, are sometimes roasted and used as a substitute for coffee. Gleditschia triacanthos is the Honey locust of the Middle and Southern States, conspicuous for its numerous sharp spines.

Sub-order 3. *Mimoseæ.* Sepals and petals valvate in æstivation, regular; the latter hypogynous, distinct, or more or less united. Stamens as many as the petals, or very numerous (five to two hundred), hypogynous or inserted into the base of the corolla. Embryo straight. Leaves paripinnate or bipinnate. Flowers most frequently polygamous.

Tribe 1. *Parkieæ.* Æstivation of the calyx and corolla imbricated. Examples: Erythrophlœum, Parkia.

Tribe 2. *Acacieæ.* Æstivation of calyx and corolla valvate. Examples: *Algarobia, *Mimosa, *Acacia. Species of Acacia furnish various gums, as Gum arabic, Gum senegal, Barbary gum, &c. The pinnate leaves of Mimosa sensitiva and pudica display a peculiar irritability when touched, and are hence called sensitive plants.

Glycyrrhiza glabra, Liquorice wood (Southern Europe) (*pl.* 70, *fig.* 14); *a–g*.

Phaseolus vulgaris (Europe) (*pl.* 70, *fig.* 11).

Indigofera anil, Indigo (East Indies) (*pl.* 70, *fig.* 13); *a*, fruit and flower-bearing branch; *b*, a flower of the natural size; *c*, anthers; *d–e*, legumes; *f*, seed.

Genista tinctoria (Europe) (*pl.* 70, *fig.* 12); *f*, the stigma. The remaining figures are easily recognisable.

Coronilla varia (Europe) (*pl.* 70, *fig.* 10); *a*, flowering branch; *b*, calyx; *c*, vexillum; *d*, ala; *e*, carina; *f*, stamens; *g*, stigma; *h*, legume; *i*, ditto opened; *k–l*, seed.

Acacia vera, Gum arabic tree (Northern Africa) (*pl.* 70, *fig.* 6); the different figures will readily be understood.

Cassia lanceolata, Senna (Upper Egypt and Nubia) (*pl.* 70, *fig.* 7); flowering branch, half opened legume and seed.

Tamarindus indica, Tamarind tree (South Asia and Central Africa) (*pl.* 70, *fig.* 8); *a*, flowering branch; *b*, sexual apparatus; *c*, calyx and ovary in cross-section; *d*, legume, partly in section; *e*, seed.

Hæmatoxylon campeachianum, Logwood (central America) (*pl.* 70, *fig.* 9); *a*, flowering branch; *b*, cross-section of the young wood; *c*, flower; *d*, do. from beneath; *e*, portion of a flower with pistil, two stamens, a petal, and a sepal; *f*, sexual apparatus of natural size; *g–i*, buds; *k*, a legume.

ORDER 155. CONNARACEÆ, the Connarus Family. Flowers bisexual, rarely unisexual. Calyx five-partite, regular, persistent; æstivation imbricate or valvate. Petals five, inserted at the base of the calyx. Stamens twice as many as the petals, inserted with them, and doubtfully hypogynous; filaments united at the base. Ovary consisting of one or more separate carpels, each having a terminal style, and a dilated stigma; ovules in pairs, collateral, ascending, orthotropal. Fruit follicular, dehiscing along the ventral suture. Seeds solitary or in pairs, erect, with or without albumen, sometimes arillate; embryo with a superior radicle, remote from the hilum, and cotyledons, which are either fleshy or leafy. Trees or shrubs, with compound, alternate, exstipulate leaves, which are not dotted. They are tropical plants, some of which have febrifuge properties. Omphalobium lamberti is said to furnish Zebrawood. This order, as well as the orders Anacardiaceæ and Amyridaceæ, are by many considered truly hypogynous, and as belonging to Thalamifloræ. Lindley notices five genera, and forty-one species. Examples: Connarus, Omphalobium, Cnestis.

ORDER 156. AMYRIDACEÆ, the Amyris Family. Flowers usually bisexual, sometimes unisexual by abortion. Calyx persistent, regular or nearly so, with two to five divisions. Petals three to five, inserted at the base of the calyx; æstivation valvate or imbricated. Stamens twice or four times as many as the petals, perigynous. Disk covering the base of the calyx, often in a ring-like manner. Ovary superior, sessile, one- to five-celled; ovules in pairs, anatropal, pendulous or suspended; style one or none; stigma simple or lobed, sometimes capitate. Fruit dry, one- to five-celled, indehiscent, or its epicarp splitting into valves. Seeds solitary, exalbuminous, with a superior radicle next the hilum, and cotyledons, which are fleshy or wrinkled. Trees or shrubs, abounding in resin, with opposite or alternate compound leaves, which are frequently stipulate and dotted. They are natives of tropical regions. There are two sub-orders:

Sub-order 1. *Amyrideæ*, with an unilocular ovary.

Sub-order 2. *Bursereæ*, with a two- to five-celled ovary. Some look upon the stamens of Amyrideæ as truly hypogynous, and consider the order as allied to Aurantiaceæ.

Lindley gives twenty-two genera, and forty-five species. Examples: *Amyris, Boswellia, Bursera, Balsamodendron. Amyris floridana is the sole North American representative.

Various balsamic and resinous substances are obtained from plants of this order. One of these is gum elemi. Olibanum, or the true Frankincense, is

a product of Boswellia serrata, a large Indian tree. Balsamodendron myrrha, a native of Abyssinia, supplies myrrh; other species yield Bdellium, and B. gileadense, Balm of Gilead.

ORDER 157. ANACARDIACEÆ, the Cashew-nut Family. Flowers usually unisexual. Calyx usually small and persistent, with five, or sometimes three, four, or seven divisions. Petals equal in number to the calycine divisions, perigynous, sometimes 0; imbricated in æstivation. Stamens either equal to the petals in number, and alternate with them, or twice as many or more; filaments distinct or cohering at the base, usually perigynous. Disk fleshy, annular, or cup-shaped, sometimes inconspicuous. Ovary single, rarely five or six, free or adhering to the calyx, one-celled; ovule solitary, attached by a funiculus to the bottom, or along the side of the cell; styles one to three, occasionally four; stigmas one to three or four. Fruit usually drupaceous and indehiscent. Seed ascending or frequently pendulous, from the adherence of the funiculus to the angle of the cell, exalbuminous; radicle inferior or superior, sometimes curved suddenly back; cotyledons thick, fleshy, or leafy. Trees or shrubs, with a resinous, often caustic juice, and alternate leaves without dots. The order is a subdivision of the Terebinthaceæ of Jussieu. The plants inhabit chiefly the tropical parts of America, Africa, and India; some, however, are found in Europe. There are forty-one known genera and ninety-five species. Examples: Anacardium, Rhus, Mangifera, Spondias.

Many species possess a caustic and poisonous juice. Some furnish edible fruit. The Cashew-nut is obtained from Anacardium occidentale. The Pistacia-nut is the fruit of Pistacia vera, cultivated in the south of Europe. P. terebinthus supplies Chian turpentine, and P. lentiscus, the substance called mastic. Some species of Rhus, found in the United States, as R. toxicodendron, poison oak and poison vine, and R. venenata, known as poison or swamp sumach, are much to be dreaded by persons of particular constitutions, simple contact in many cases producing severe inflammation of the skin. Some (not very well authenticated) instances are on record, where simple proximity, with the wind blowing through the plant on an individual, has caused the characteristic affection of the skin. Some persons are able to handle these poisonous species of Rhus with impunity. R. aromatica has highly fragrant leaves. R. typhina, copallina, and glabra, are harmless North American species, known as sumachs, whose leaves and young shoots, with those of R. coriaria, a European species, furnish the tanner's sumach. Some species of the order supply varnishes. Japan Lacquer is the juice of Stagmaria verniciflua; Sylhet varnish, that of Semecarpus anacardium.

Rhus cotinus, the Smoke tree, Southern Europe (*pl.* 71, *fig.* 2); *a*, a flowering branch; *b*, a flower magnified; *c*, ditto without the petals; *d*, an anther; *e*, *f*, fruit.

Anacardium occidentale, Cashew-nut, West Indies (*pl.* 71, *fig.* 1); *a*, branch with flowers and fruit; *b*, flower; *c*, calyx; *d*, staminal tube; *e*, ditto laid open; *f*, pistil; *g*, cross-section of the nut.

Pistacia terebinthus, Turpentine tree, Mediterranean coast (*pl.* 71, *fig.* 3);

a, flowering branch; *b*, male flower; *c*, anther; *d*, female flowers; *e*, pistil; *f*, fruit; *g*, section of ditto.

ORDER 158. RHAMNACEÆ, the Buckthorn Family. Calyx four- or five-cleft, valvate in æstivation. Petals distinct, hooded, or convolute, inserted into the throat of the calyx, sometimes 0. Stamens definite, opposite the petals. Disk large, fleshy, flat, or urceolate. Ovary superior or half superior, two-, three-, or four-celled; ovules solitary, erect, anatropal. Fruit fleshy and indehiscent, or dry and separating into three parts. Seeds erect; albumen fleshy, rarely 0; embryo about as long as the seed, with a short inferior radicle, and large flat cotyledons. Trees or shrubs, often spiny, with simple, alternate, rarely opposite leaves, and minute stipules. They are generally distributed over the globe, and are found both in temperate and tropical regions. There are 43 genera and 250 species enumerated. Of these four genera and thirty-four species are cited as North American by Torrey and Gray.

Tribe 1. *Paliureæ.* Shrubs of the Old World with alternate leaves. Fruit semi-adherent, dry, crowned by a transversely circular wing. Example: Ventilago.

Tribe 2. *Franguleæ.* Trees or shrubs spread over the temperate zones; with alternate leaves. Fruit without wings, free or semi-adherent, fleshy or capsular, with the shell indehiscent or opening by an internal fissure. Examples: *Berchemia, *Sageretia, *Rhamnus, *Ceanothus.

Tribe 3. *Pomaderreæ.* Unarmed Australian shrubs with alternate leaves. Fruit wingless, capsular, the shell opening by an introrse perforation, covered by a membrane. Example: Trymalium.

Tribe 4. *Colletieæ.* Shrubs of temperate South America, the branches terminated by a spine, leaves decussate, sometimes almost none. Fruit wingless, free. Example: Colletia.

Tribe 5. *Phyliceæ.* Shrubs of the Cape and of extra-tropical Australia; unarmed, leaves alternate. Fruit wingless, adherent, and crowned by the calyx, capsular. Example: Spyridium.

Tribe 6. *Gouanieæ.* Lianas or herbs of the tropics, or of South Africa; unarmed. Fruit adherent, separating by shells usually winged longitudinally on the back, opening by an internal fissure. Example: Helinus.

Rhamnus catharticus or the Buckthorn, naturalized in the United States, is sometimes used medicinally. The greenish juice, when mixed with lime and evaporated to dryness, forms the color called sap green. French berries used in dyeing yellow are obtained from R. infectorius. Various species are native in North America. Jujube is the fruit of Zizyphus jujuba. The Lotus of the ancients is a second species, Z. lotus. The leaves of Ceanothus americanus were used in the revolutionary war as a substitute for tea.

Rhamnus catharticus, Buckthorn (Europe) (*pl.* 71, *fig.* 7); *a*, a flowering branch; *b*, a male; *c*, a female flower; *d*, a fruit; *e*, ditto with part of the flesh removed; *f*, the seed; *g*, do. in cross-section.

ORDER 159. STAPHYLEACEÆ, the Bladder-nut Family. Sepals five, united

at the base, colored, imbricated in æstivation. Petals five, alternate with an imbricated æstivation. Stamens five, alternate with the petals. Disk large and urceolate. Ovary two- to three-celled, superior; ovules usually ascending; styles two to three, cohering at the base. Fruit membranous or fleshy, indehiscent, or opening internally, often partly abortive. Seeds anatropal, roundish, truncated at the hilum, with a bony testa; albumen generally 0; embryo straight, with thick cotyledons and a small inferior radicle. Shrubs, with opposite, pinnate leaves, having stipules and stipels. The plants are irregularly scattered over the globe, and are found in Europe, America, and Asia. Some of them appear to be subacrid, while others are bitter and astringent. The species of Staphylea receive the name of Bladder-nut, on account of their inflated bladder-like pericarp. They are cultivated as handsome shrubs. Three known genera are enumerated, and fourteen species. Example: *Staphylea. Staphylea trifolia, or Bladder-nut, represents this order in America.

Order 160. Celastraceæ, the Spindle-tree Family. Sepals four to five, imbricated in æstivation. Petals four to five, with a broad base, and an imbricated æstivation, rarely wanting. Stamens alternate with the petals; anthers erect. Disk large, flat, and expanded, surrounding the ovary, to which it adheres. Ovary superior, two- to five-celled; ovules ascending, one or numerous, attached to the axis by a short funiculus. Fruit either a two- to five-celled capsule, with loculicidal dehiscence, or drupaceous. Seeds one or many in each cell, anatropal, usually ascending, and sometimes arillate; albumen fleshy; embryo straight, with flat cotyledons and a short radicle. Small trees or shrubs, with simple, alternate, rarely opposite leaves, and small deciduous stipules. They inhabit the warm parts of Europe, North America, and Asia, and many are found at the Cape of Good Hope. The order contains twenty-four known genera, and 260 species. It has been divided into two tribes: 1. Euonymeæ, with capsular fruit. 2. Elæodendreæ, with drupaceous fruit. Examples: *Celastrus, *Euonymus, *Oreophila, Elæodendron. Some authors include the last order with Celastraceæ, as a sub-order. In North America there are three genera (Euonymus, Celastrus, and Oreophila), with five species. Euonymus americanus is called burning bush, from the bright scarlet arillodes and crimson capsules.

Euonymus europæus, Spindle tree (Europe) (*pl.* 71, *fig.* 5); *a*, flowering branch; *b*, flower; *c*, fruit; *d*, seed; *e*, vertical section of do.

Order 161. Stackhousiaceæ, the Stackhousia Family. Calyx five-cleft, equal, with an inflated tube. Petals five, equal, inserted at the top of the tube of the calyx, claws of the petals united, limb narrow and stellate. Stamens five, unequal, attached to the tubes of the calyx. Ovary superior, three- to five-celled, cells partially distinct; ovules solitary, erect; styles three to five, sometimes united at the base; stigmas simple. Fruit consisting of three to five indehiscent pieces, which are sometimes winged, and are attached to a central persistent column. Seeds anatropal; embryo long, erect, in the axis of fleshy albumen. Shrubs with simple, entire, alternate,

stipulate leaves, found in New Holland, and not possessing any marked properties. Lindley notices two genera and ten species. Example: Stackhousia.

Sub-class 4. *Thalamifloræ.*

Calyx and corolla present; petals distinct, inserted into the thalamus or receptacle; stamens hypogynous. This includes the hypogynous polypetalous orders of Jussieu, and a diclinous order (Menispermaceæ). Sometimes the petals are abortive, and it is then difficult to determine whether the plant belongs to this sub-class, or to Monochlamydeæ.

ORDER 162. CORIARIACEÆ, the Coriaria Family. Flowers unisexual. Calyx campanulate, five-parted; æstivation imbricate. Petals alternate with the calycine segments, very small, fleshy, with a keel on the internal surface. Stamens ten; filaments filiform, distinct; anthers dithecal, oblong. Ovary composed usually of five carpels, attached to a thickened receptacle or gynobase, five-celled; ovules solitary, pendulous; style 0; stigmas five, long and glandular. Fruit, consisting of five monospermous, indehiscent, crustaceous carpels, inclosed by the enlarged petals. Seeds pendulous, anatropal, exalbuminous; embryo nearly straight; cotyledons fleshy; radicle short and blunt. Shrubs with opposite square branches, opposite, simple, ribbed leaves, and scaly buds. They are found in small numbers in the south of Europe, South America, India, and New Zealand. Some of them are poisonous. Eight species of the single genus Coriaria are known.

ORDER 163. OCHNACEÆ, the Ochna Family. Sepals five, persistent, imbricated in æstivation. Petals equal to, or twice as many as the sepals, deciduous, spreading, imbricated in æstivation. Stamens five, opposite the sepals, or ten, or indefinite; filaments persistent, attached to a hypogynous disk; anthers bilocular, innate, opening by pores, or longitudinally. Carpels as many as the petals, seated on an enlarged gynobase (thecaphore): ovule erect or pendulous, styles united into one. Fruit gynobasic, consisting of several succulent, indehiscent, monospermous carpels. Seeds anatropal, usually exalbuminous; embryo straight; radicle short; cotyledons thick. Undershrubs or trees, with alternate, simple, stipulate leaves, and pedicels articulated in the middle. They grow in tropical countries, and are remarkable for the large succulent prolongation of the receptacle to which the carpels are attached. They are generally bitter, and some of them are used as tonics. Lindley enumerates six genera, comprehending eighty-two species. Examples: Ochna, Gomphia, *Castela. This order is represented in North America by a single species, Castela nicholsonii.

ORDER 164. SIMARUBACEÆ, the Quassia and Simaruba Family. Flowers usually hermaphrodite. Calyx in four or five divisions; æstivation imbricated. Petals four or five, spreading or connivent into a kind of tube; æstivation twisted. Stamens twice as many as the petals; filaments arising from scales. Ovary four- or five-lobed, four- or five-celled, supported on a gynophore; ovules solitary; style simple; stigma four- or five-lobed.

Fruit indehiscent, consisting of four or five drupes, arranged round a common receptacle. Seeds anatropal, pendulous; embryo exalbuminous. Trees or shrubs, with exstipulate, alternate, usually compound leaves, without dots. They are found in the tropical parts of America, Asia, and Africa. Lindley gives ten genera and thirty-five species. Examples: Simaruba, Quassia, Picræna. All the plants of this order are intensely bitter. Quassia of commerce is obtained from Quassia amara, a Surinam shrub, and from Picræna excelsa, a native of the West Indies. It is sometimes used illegally by brewers as a substitute for hops.

Order 165. Zanthoxylaceæ, the Zanthoxylon Family. Flowers unisexual. Calyx in three, four, or five segments, with imbricated æstivation. Petals the same in number, rarely 0, usually larger than the calyx; æstivation imbricated or convolute. Stamens as many, or twice as many as the petals, not developed in the female flowers. Ovary consisting of as many carpels as there are petals (sometimes fewer), the carpels being either completely or partially united; ovules two, rarely four, in each carpel; styles more or less combined. Fruit baccate or membranous, sometimes of two to five cells, sometimes of several drupes, or two-valved capsules, of which the fleshy sarcocarp is partly separable from the endocarp. Seeds solitary or in pairs, pendulous; embryo lying within fleshy albumen; radicle superior; cotyledons ovate, flat. Trees or shrubs, with exstipulate, alternate, or opposite leaves, having pellucid dots. They exist chiefly in the tropical parts of America. Lindley enumerates 20 genera, including 110 species. The North American genera are Zanthoxylum, Ptelea, and Pitavia, with five species. Z. americanus, known as prickly ash, or toothache tree, has an aromatic pungency in the leaves, bark, and berries.

Order 166. Rutaceæ, the Rue Family. Calyx having four or five segments, with an imbricated æstivation. Petals alternate with the divisions of the calyx, distinct, or cohering below into a spurious gamopetalous corolla, rarely wanting; æstivation either contorted or valvate. Stamens equal in number to the petals, or twice or thrice as many (rarely fewer by abortion or non-development), usually hypogynous, but in some instances perigynous. Between the stamens and ovary there is a more or less cup-shaped disk, which is either free or united to the calyx. Ovary sessile or supported on a gynophore, its carpels equal to the petals in number, or fewer; ovules two, rarely four or fewer in each carpel; styles adherent above; stigma simple or dilated. Fruit capsular, its parts either combined completely or partially; seeds solitary or in pairs, albuminous or exalbuminous; embryo with a superior radicle. Trees or shrubs, with exstipulate, opposite, or alternate leaves, usually covered with pellucid, resinous dots, and hermaphrodite flowers. The order has been sub-divided into two sub-orders:

Sub-order 1. *Ruteæ*, with albuminous seeds, and the fruit, with sarcocarp and endocarp combined.

Sub-order 2. *Diosmeæ*, with exalbuminous seeds and a two-valved endocarp, which dehisces at the base, and when the fruit is ripe separates from

a two-valved sarcocarp. Ruteæ are found chiefly in the southern part of the temperate zone, as in the south of Europe, while Diosmeæ abound at the Cape of Good Hope and in New Holland. The recently discovered Rutosma texensis is the sole representative of the Ruteæ in America. Lindley mentions 48 genera and 400 species. Examples: Ruta, Dictamnus, Diosma, Barosma, Correa, Boronia, *Rutosma.

Dictamnus albus (*pl.* 68, *fig.* 10); *a*, *b*, a flower branch and leaf; *c*, stamen; *d*, pistil; *e*, burst capsule; *f*, half of the capsule with the endocarp separated; *g*, endocarp with the seed; *h*, a seed.

Order 167. Zygophyllaceæ, the Guaiacum Family. Calyx four- or five-parted, with convolute æstivation. Petals alternate with the calycine segments, with imbricated æstivation. Stamens twice as many as the petals; filaments dilated at the base, usually arising from scales. Ovary simple, four- or five-celled; divisions occasionally formed by spurious dissepiments. Ovules two or more in each cell, usually pendulous; style simple, four- or five-furrowed; stigma simple, or four- or five-lobed. Fruit capsular, or rarely fleshy, with four or five angles or wings, four- or five-valved, either opening by loculicidal dehiscence, or indehiscent. Seeds few, usually with whitish albumen, sometimes exalbuminous; embryo green, with foliaceous cotyledons, and a superior radicle. Herbs, shrubs, or trees, with opposite, stipulate, usually compound leaves, which are not dotted, and hermaphrodite flowers. They occur in various parts of the world, chiefly in warm extratropical regions, as in the south of Europe, America, Africa, and India. The order has been divided into two sections; 1. Zygophylleæ, having albuminous seeds. 2. Tribuleæ, having exalbuminous seeds. Lindley mentions seven genera, comprising one hundred species. Examples: Zygophyllum, Guaiacum, Tribulus, *Kallstrœma. The order is represented in North America by Kallstrœma maxima alone. Jussieu includes the last four orders as sub-orders, under one general order, Zygophyllaceæ. The wood of Guaiacum officinale, a West Indian tree, is known as lignum vitæ. This species yields a resinous matter, known as Gum guaiac.

Guaiacum officinale (*pl.* 68, *fig.* 9); *a*, flowering branch; *b*, anthers; *c*, pistil; *d*, an ovule magnified; *e*, fruit.

Order 168. Brexiaceæ, the Brexia Family. Calyx small, persistent, of five coherent sepals, with an imbricated æstivation. Petals five, with twisted æstivation. Stamens five, alternate with the petals, arising from a narrow cup or disk, which is toothed between each stamen; anthers bilocular, erect, opening longitudinally and introrsely. Ovary five-celled; ovules numerous, in two rows; placentas central; style one; stigma simple. Fruit drupaceous, five-celled, many-seeded. Seeds having two distinct coverings, anatropal; embryo straight; radicle cylindrical; cotyledons ovate, obtuse. Trees with coriaceous, alternate leaves, having small deciduous stipules. They exist principally in Madagascar. Lindley associates some perigynous genera with Brexia, and places the order near Saxifragaceæ. He enumerates four genera, including six species. Example: Brexia.

Order 169. Pittosporaceæ, the Pittosporum Family. Sepals four or five,

deciduous, distinct, or partially united; æstivation imbricated. Petals four or five, sometimes slightly cohering, with imbricated æstivation. Stamens five, distinct, alternate with the petals. Ovary single, two- to five-celled; style, one; stigmas two to five, equal in number to the placentas. Fruit capsular or berried, with many-seeded cells, which are sometimes incomplete; dehiscence loculicidal. Seeds often enveloped in a glutinous or resinous pulp, anatropal, with a minute embryo lying in fleshy albumen; radicle long; cotyledons very short. Trees or shrubs, with simple, alternate, exstipulate leaves and flowers, occasionally polygamous. They are found chiefly in Australia. Many of them are resinous, and, in some instances, the berries are eaten. Lindley mentions twelve genera, including seventy-eight species. Examples: Pittosporum, Billardiera, Sollya.

ORDER 170. TROPÆOLACEÆ, the Indian Cress Family. Sepals usually five, the upper spurred; æstivation slightly imbricate. Petals often five, hypogynous, more or less unequal, sometimes abortive; æstivation convolute. Stamens eight or ten, seldom fewer, free, almost perigynous; anthers bilocular, innate. Ovary triquetrous, composed of three to five carpels, with a single style, and three to five acute stigmas; ovules solitary, often pendulous. Fruit indehiscent, usually composed of three pieces. Seeds exalbuminous, with a large embryo, which has thick, often united cotyledons, and a radicle next the hilum. Herbaceous trailing or twining plants, having a delicate texture, with alternate, exstipulate leaves, and axillary, often gay flowers. They are extensively cultivated on account of their showy yellow, orange, scarlet, and occasionally blue flowers. They have more or less pungency in their fruit, which is used as a cress. The unripe fruit of Tropæolum majus, common Indian cress, has been pickled and used as capers. Their roots are sometimes eaten. Lindley includes Limnantheæ in this order, and enumerates six genera, including forty-four species. Example: Tropæolum.

ORDER 171. OXALIDACEÆ, the Wood-Sorrel Family. Sepals five, equal, sometimes cohering slightly at the base, persistent, imbricate in æstivation. Petals five, equal, unguiculate, hypogynous, with a twisted æstivation. Stamens ten, more or less monadelphous, in two rows; those opposite the petals being longer than those in the outer row; anthers erect, bilocular. Ovary usually quinquelocular; styles filiform, distinct; stigmas capitate or slightly bifid. Fruit capsular, membranous or fleshy, usually five-celled, and when dehiscent five- to ten-valved. Seeds few, anatropal, albuminous, attached to a central placenta, sometimes with a peculiar elastic integument; embryo straight, as long as the fleshy albumen, with a long radicle and leafy cotyledons. Herbs, undershrubs, or trees, with alternate, rarely opposite compound (occasionally simple) leaves, which are generally without stipules. They are found in the hot as well as the temperate parts of the world, and are abundant in North America and at the Cape of Good Hope. In some cases phyllodia, or winged petioles, occupy the place of leaves. There are about six known genera, and upwards of 320 species. Examples: Oxalis, Averrhoa, Hugonia. Five species of Oxalis represent this order in North America. One of the species, O. acetosella, has an acid taste derived from

the binoxalate of potassa which it contains. Some species yield tubers which have been used as substitutes for potatoes.

Oxalis acetosella, Wood Sorrel (Europe and America) (*pl.* 67, *fig.* 10); *a*, plant with the rhizome; *b*, petal; *c*, stamens; *d*, capsule; *e*, do. burst; *f*, cross-section; *g–h*, seed.

ORDER 172. BALSAMINACEÆ, the Balsam Family. Sepals five, irregular, deciduous, the two inner and upper connate, colored, the lower (odd) sepal spurred; æstivation imbricated. Petals alternate with the sepals, usually four, in consequence of one being abortive, often more or less irregularly united; æstivation convolute. Stamens five. Ovary five-celled; ovules usually numerous; stigma sessile, more or less five-lobed. Fruit a five-celled capsule, opening septifragally, by five elastic valves. Seeds usually numerous, suspended, exalbuminous, with a straight embryo, and radicle next the hilum. Succulent herbaceous plants with watery juice, having simple, opposite, or alternate, exstipulate leaves, and axillary irregular flowers. They inhabit chiefly the East Indies, and are remarkable for the force with which the seed vessels open when ripe. The valves give way on account of the exosmose which goes on in the cells, and they then curl up in a peculiar manner. They have usually showy flowers, but their properties are unimportant. Lindley mentions two genera, including 110 species. Examples: *Impatiens, Hydrocera. The sole North American representatives are two species of Impatiens, known as glass weed, and considered by some of the Indian tribes as efficacious in the bite of rattlesnakes.

ORDER 173. LINACEÆ, the Flax Family. Sepals three, four, or five, persistent, with an imbricated æstivation. Petals three, four, or five, fugitive, unguiculate, hypogynous, with a twisted æstivation. Stamens equal to the petals and alternate with them (with intermediate teeth or abortive stamens), arising from a hypogynous annular disk; anthers ovate, erect. Ovary with as many cells and styles as sepals, seldom fewer; stigmas capitate; ovules anatropal, pendulous. Fruit a plurilocular capsule, pointed generally with the indurated base of the styles; each loculament or cell more or less completely divided by a spurious dissepiment, arising from the dorsal suture, and opening by two valves at the apex. Seeds solitary in each spurious cell, compressed, pendulous; albumen usually in small quantity, sometimes 0; embryo straight; cotyledons flat; radicle next the hilum. Annual and perennial plants, with exstipulate, simple, entire leaves, which are usually alternate. They are scattered over the globe, but are said to be most abundant in Europe, and in the north of Africa. By some authors the order is associated with Geraniaceæ, from which it differs in its unbeaked fruit and exstipulate leaves, as well as the absence of joints in the stem. There are three genera mentioned by Lindley, comprising ninety species. Examples: Linum, Radiola. There are six North American species of Linum. The principal plant of the order is Linum usitatissimum, or the Flax plant. Flax is the woody fibre procured from the inner bark of the stalk, by steeping and stripping off the outer bark. When worked up it forms the various linen fabrics. Mummy cloth is made of linen, as is

well shown by its microscopical structure. The integument of the seed is mucilaginous, and the cotyledons yield linseed oil by expression.

Linum usitatissimum, Flax (Egypt originally) (*pl.* 68, *fig.* 13); *a*, flowering branch; *b*, sepal; *c*, sexual apparatus; *d*, petal; *e*, *f*, seed.

ORDER 174. GERANIACEÆ, the Cranesbill Family. Sepals five, persistent, more or less unequal, one sometimes spurred at the base; æstivation imbricated. Petals five (or by abortion four), unguiculate, with contorted æstivation. Stamens monadelphous, hypogynous, twice or thrice as many as the petals, some occasionally abortive. Ovary of five carpels, placed round an elongated axis; ovules pendulous, solitary; styles five, cohering round the axis. Fruit formed of five one-seeded cocci, terminated each by an indurated style, which curls upwards, carrying the coccus or pericarp with it. Seeds exalbuminous, solitary, with a curved folded embryo, and leafy, convolute, and plaited cotyledons. Herbs or shrubs with simple, stipulate leaves, which are either opposite, or alternate with peduncles opposite to them. They are distributed over various parts of the world. The species of Pelargonium abound at the Cape of Good Hope. Lindley mentions four genera, including, after separating hybrids, about five hundred species. Examples: Geranium, Pelargonium. North America possesses two genera (Geranium and Erodium), with eight species. The geraniums of the horticulturist in their different varieties, all belong to Pelargonium.

Geranium sanguineum, Cranesbill (Europe) (*pl.* 67, *fig.* 9); *a*, a flower branch; *b*, flower bud; *c*, petal of natural size; *d*, fruit; *e*, seed.

ORDER 175. VITACEÆ, the Vine Family. Calyx small, nearly entire. Petals four to five, sometimes cohering above, inserted outside an annular hypogynous disk; æstivation valvate. Stamens four to five, opposite to the petals, inserted on the disk; filaments free, or united at the base; anthers ovate, versatile. Ovary two- to six-celled; ovules erect, anatropal; style one, very short; stigma simple. Fruit pulpy and globular, not united to the calyx, sometimes one-celled by abortion. Seeds one to four or five, erect, with an osseous spermoderm, horny albumen, and an erect embryo. Climbing shrubs, having the lower leaves opposite, the upper ones alternate. Flowers in racemes, which are often opposite the leaves; floral peduncles sometimes becoming cirrhose. They inhabit the milder as well as the hotter parts of both hemispheres, and abound in the West Indies. There are seven genera and 260 species. Examples: *Vitis, *Cissus, *Ampelopsis.

Of this limited order, North America possesses the three genera enumerated above, with nine species. Ampelopsis quinquefolia is a well known climbing shrub, called American ivy or Virginian creeper, which runs along fences and up trees, and is capable of adhering to the sides of houses and walls by expansions of the extremities of the tendrils. Owing to its rapid growth and intrinsic beauty, it is in much request as an ornamental plant. The leaves in autumn acquire the deepest crimson tint of any American species. It is perfectly innocuous, although looked on with suspicion on account of a general resemblance to the poison vine (Rhus radicans), from which it may always be readily distinguished by the leaflets occurring in groups of fives and not of threes as in the latter species. The

most important plants of the order are the various species of Vitis or Vine, of which there are five species in the United States. One of these, Vitis labrusca or the Fox grape of the northern States, is probably the progenitor of the varieties known as the Isabella, the Catawba, and others. Vitis vulpina, the Fox grape of the South, affords a pleasant fruit, and has probably some cultivated varieties. The remaining North American species are of little value. The native abode of the typical vine, Vitis vinifera, is not known in its whole extent. It occurs wild in many parts of Europe, Asia, and Africa, yet many localities of the kind may have been originally supplied by plants which had been introduced from other places. Most authors fix the original seat of this important species in the old Cyrenaica, in the country between the Black and Caspian Seas. Here the vine attains to a diameter of three to six inches, and mounts to the tops of the highest trees. Omitting as unsuited to this part of our work, the details of wine manufacture, we shall proceed to mention some of the principal varieties of this liquor as it occurs in commerce.

Wines are distinguished in the first place into white and red. The white are more or less yellow or brown, becoming darker by age; the red derive their color from the skins of the grapes, which are allowed to remain in contact with the juice for a certain length of time. Of the Rhenish wines the Asmannshäuser is red, the Johannisberger, the Markobrunner, and the Hochheimer, are white. The Leistenwein, Steinwein, Calmuth, Würzburger, and Werthheimer, come from Franconia. The Melnicker comes from Bohemia, Moselle from Trier and Coblentz: the Affenthaler from Baden. The principal Hungarian wines are the Tokay, Menesch, Oedenburger, and Ofen. The principal French wines are the white and red Bordeaux: Medoc, Graves, and Burgundy: the champagnes, especially the foaming, from Silleray, Epernay, &c. The Spanish wines are mostly yellowish brown, or red, and sweet, as Sherry, Malaga, Benicarlo, &c. Port is a highly prized Portuguese wine; Madeira wine, and the Constantia from the Cape of Good Hope, are much esteemed. Italian and Greek wines are generally excellent, but rarely occur in commerce.

Vitis vinifera, wine grape (*pl.* 67, *fig.* 8); *a*, a branch with flowers and tendrils; *b*, a bunch of grapes; *c*, ovary; *d*, sexual apparatus; *e*, a perfect flower; *f*, cross-section of ovary; *g*, pistil; *h*, section of ovary; *i–k*, seed.

Order 176. Cedrelaceæ, the Mahogany Family. Calyx four- to five-cleft, with imbricated æstivation. Petals four to five, with imbricated æstivation. Stamens eight to ten, united below into a tube, sometimes distinct, inserted into a hypogynous annular disk; anthers bilocular, acuminated, with longitudinal dehiscence. Ovary usually four- or five-celled; ovules anatropal, pendulous; style simple; stigma peltate. Fruit a capsule opening septifragally. Seeds winged; albumen thin or 0; embryo straight, erect; cotyledons fleshy. Trees with alternate, pinnate, exstipulate leaves. They are found in the tropical parts of America and Asia. Lindley enumerates nine genera, including twenty-five species. Examples: Cedrela, *Swietenia. This order includes as its most important species, the mahogany tree, Swietenia mahogoni, a native of the West Indies and

of central America, and probably of Florida. Most of the mahogany wood of commerce comes from the bay of Honduras, and is brought in logs. One of the largest logs ever exported was seventeen feet long, fifty-seven inches broad, and sixty-four inches thick, weighing 30,000lbs.

Swietenia mahogoni, Mahogany tree (*pl.* 67, *fig.* 7); *a*, a flowering branch; *b*, corolla with staminal tube; *c*, the latter expanded; *d*, anther; *e*, pistil; *f*, cross-section of ovary; *g*, capsule; *h*, ditto opened; *i*, a winged seed.

ORDER 177. MELIACEÆ, the Melia Family. Sepals four to five, more or less united, with an imbricated æstivation. Petals four to five, hypogynous, sometimes cohering at the base, with a valvate or imbricated æstivation. Stamens equal in number to the petals, or two, three, or four times as many; filaments combined in a long tube; anthers sessile within the orifice of the tube. Disk often large and cup-shaped. Ovary single, plurilocular, the cells often equal in number to the petals; ovules usually anatropal, one to two in each cell; style one; stigmas distinct or united. Fruit baccate, drupaceous or capsular, multilocular or by abortion unilocular, when valves are present opening by loculicidal dehiscence. Seeds not winged; albumen usually absent; embryo straight, with leafy cotyledons. Trees or shrubs with alternate (occasionally opposite), exstipulate, simple, or pinnate leaves. They are chiefly found in the tropical parts of America and Asia. *Tribe* 1. *Melieæ.* Embryo in a perisperm. Leaflets often dentated. Example: Melia. *Tribe* 2. *Trichilieæ.* Embryo without perisperm. Leaflets very entire. Example: Trichilia.

Of the entire order there are about forty genera and 160 species. There are none North American. Melia azedarach, however, is naturalized in the southern States. It is there known as the Pride of China.

ORDER 178. RHIZOBOLACEÆ, the Souari-Nut Family. Sepals five, more or less combined; æstivation imbricated. Petals usually five, unequal, thickish. Stamens indefinite, slightly monadelphous, arising from a hypogynous disk, in a double row of which the inner is often abortive; anthers roundish, with longitudinal dehiscence. Ovary four- to five-celled; ovules solitary, semi-anatropal; styles as many as the cells of the ovary; stigmas simple. Fruit formed of several indehiscent, one-celled, one-seeded nuts, with a thick double endocarp. Seeds reniform, exalbuminous, with the funiculus dilated into a spongy excrescence; embryo with a very large radicle, which constitutes nearly the whole of the kernel; cotyledons small, lying in a furrow of the radicle. Trees with opposite, palmately compound, coriaceous, exstipulate leaves. They grow in the warm forests of South America. Some of them furnish oil, others yield edible nuts. Souari nuts are the produce of Caryocar butyrosum (Pekea butyrosa). Lindley notices two genera and eight species. Examples: Caryocar, Anthodiscus.

ORDER 179. SAPINDACEÆ. Flowers usually polygamous. Sepals four to five, distinct or nearly so, imbricated in æstivation. Petals as many as the sepals and alternate with them, or fewer by the abortion of one (sometimes entirely wanting), inserted outside the hypogynous disk (or row of glands) which occupies the bottom of the calyx; the inside either naked or hairy, glandular or furnished with a petaloid scale. Stamens eight or ten, rarely

fewer or more numerous, inserted either on the disk or between the glands and the ovary; filaments distinct or very slightly united at the base; anthers introrse (the pistil of the staminate flowers either rudimentary or entirely wanting). Ovary composed of three (rarely two to five) united carpels; styles partly or completely united; ovules solitary in each cell; erect or ascending; sometimes two, the upper one ascending, the lower suspended; rarely three or more. Fruit two- to three-celled, capsular, vesicular, or samaroid, or frequently fleshy and indehiscent. Seeds one to three in each cell, usually arilled, without albumen. Embryo rarely straight; the cotyledons usually incumbent on the radicle, or spirally convolute, sometimes combined into a thick mass. Trees or tendril-bearing shrubs or herbs. Leaves alternate, usually compound and exstipulate, often marked with pellucid lines or dots. Flowers small. *Tribe* 1. *Sapindeæ.* Ovary with one ovule in each cell. Embryo curved or rarely straight. Examples: *Cardiospermum, *Sapindus, Paullinia. *Tribe* 2. *Dodonæaceæ.* Ovary with two to three (rarely more) ovules in each cell. Embryo spirally convolute. Example: *Dodonæa.

The entire order embraces nearly sixty genera; of which three, with as many species, are North American. The fruit of Sapindus saponaria, known in the West Indies as Soap berries, supplies a substitute for soap.

Paullinia pinnata (South America) (*pl.* 66, *fig.* 14); *a–d.*

ORDER 180. HIPPOCASTANEACEÆ, the Horse-Chestnut Family. Sepals five, usually united into a campanulate or tubular five-toothed calyx; æstivation imbricated. Petals five, or four by the suppression of the inferior one, commonly unequal and irregular, unguiculate, hypogynous. Stamens six to eight, commonly seven, distinct, unequal, inserted upon the hypogynous disk; anthers oval, versatile. Ovary roundish, composed of three united carpels, three-celled, with two collateral ovules in each cell; style filiform, acute. Fruit subglobose, coriaceous, three- (or frequently by suppression one- to two-) celled, two- to three-valved, with loculicidal dehiscence. Seeds solitary or very few, large, with a smooth or shining testa, and a broad pale hilum, somewhat campylotropous, with no albumen. Cotyledons very thick and fleshy, gibbous, cohering, remaining under ground in germination; radicle conical, curved; plumule large, two-leaved. Trees or shrubs. Leaves opposite (in Ungnodia alternate), exstipulate, compound; leaflets serrate. Flowers showy; pedicels articulated. This order, composed of the three genera Aesculus, Pavia, and Ungnodia, is North American, excepting a single species, Aesculus hippocastaneum, from Thibet. Native species of Aesculus are known in the United States as Buckeyes. The powdered seeds of A. pavia may be used like Cocculus Indicus, to stupefy fish. The root also may be used as a substitute for soap in washing woollen cloths.

Aesculus pavia, Small Buckeye (United States) (*pl.* 66, *fig.* 15); *a*, a flowering branch; *b*, upper and lower petals; *c*, vertical section of ovary; *d*, fruit.

ORDER 181. ACERACEÆ, the Maple Family. Calyx divided into five, rarely into four or nine parts, with an imbricated æstivation. Petals equal

in number to the lobes of the calyx, with which they alternate; rarely wanting. Stamens generally eight, inserted on a hypogynous disk. Ovary free, two-lobed, two-celled; ovules in pairs; amphitropal, pendulous; style one; stigmas two. Fruit, a samara, composed of two winged carpels, each one-celled, with one to two seeds. Seeds erect, exalbuminous; embryo curved, with foliaceous cotyledons, and the radicle next the hilum. Trees with opposite, simple, lobed or palmate, exstipulate leaves. Flowers often polygamous. They are confined chiefly to the temperate parts of Europe, Asia, and North America. They yield a saccharine sap, from which sugar is sometimes manufactured. Acer saccharinum is the Sugar Maple of America. Acer pseudo-platanus, the Sycamore or Great Maple (the Plane-tree of Scotland), acts well as a shelter or break-wind in exposed places, as near the sea. Its sap is slightly saccharine. Its wood is used in machinery and for charcoal. The leaves are often covered with black spots, caused by the attack of a fungus, Xyloma or Rytisma acerinum. There are three known genera, and sixty species. Examples: Acer, Negundo, Dobinea. Of these genera, the two first with thirteen species are North American.

Acer pseudo-platanus (Europe) (*pl.* 67, *fig.* 1); *a*, a flowering branch; *b*, a male; *c*, female flower; *d*, the winged fruit; *e*, the seed.

ORDER 182. MALPIGHIACEÆ, the Malpighia Family. Sepals five, slightly united, persistent, often glandular at the base; æstivation imbricated. Petals five, unguiculate, with convolute æstivation. Stamens usually ten, often monadelphous; anthers roundish, with a projecting process from the connective. Ovary formed by three (rarely two or four) carpels, more or less combined; ovules solitary, with a long pendulous cord; styles three, distinct or united. Fruit dry or fleshy, sometimes winged. Seeds solitary, orthotropal, suspended, exalbuminous; embryo straight or curved in various ways; cotyledons foliaceous or thickish. Trees or shrubs, sometimes climbing, with simple, opposite, or very rarely alternate, stipulate leaves without dots. Hairs, when present, peltate. Flowers either perfect or unisexual. They are inhabitants of tropical countries chiefly, and a great number of them are found in South America. Lindley notices forty-two genera, including 555 species.

Section A. Diplostemones. Number of stamens always double that of petals, some of them occasionally sterile. Styles usually two to three. The same number of ovaries united. Flowers of one form only.

Tribe 1. *Malpighieæ.* Fruit wingless. Example: Malpighia.

Tribe 2. *Banisterieæ.* Carpels provided with wings, the dorsal solely or most developed. Example: Lophopterys.

Tribe 3. *Hiræeæ.* Carpels winged; the marginal solely or most developed. Example: Molina.

Section B. Meiostemones. The whole or part of the alternipetalous stamens wanting. Style single by the abortion of two others. Ovaries distinct. Flowers of two different forms on the same plant.

Tribe 4. *Gaudichaudieæ.* Carpels with or without wings. Example: Gaudichaudia.

Malpighia urens (South America and West Indies) (*pl.* 67, *fig.* 2); *a*, flowering branch; *b*, calyx; *c*, petal; *d*, stamens and pistil.

ORDER 183. ERYTHROXYLACEÆ, the Erythroxylon Family. Sepals five, united at the base, persistent; æstivation imbricated. Petals five, hypogynous, broad and with a small scale at the base, slightly contorted in æstivation. Stamens ten, monadelphous; anthers erect; bilocular, with longitudinal dehiscence. Ovary three-celled, two of which are sometimes abortive; styles three, distinct, or united; stigmas three; ovule single, pendulous. Fruit a one-seeded drupe. Seed angular, anatropal; embryo in the axis of firm albumen, rarely exalbuminous; cotyledons linear, flat, and leafy. Shrubs or trees with alternate stipulate leaves. Flowers arising from numerous, imbricated, scale-like bracts. Found chiefly in the West Indies and South America. The plants of the order have tonic, purgative, and narcotic qualities. The leaves of Erythroxylon coca are used in Peru as a stimulant like opium. Some yield a dye. There are two or three known genera, and about eighty species. Examples: Erythroxylon, Sethia.

ORDER 184. HIPPOCRATEACEÆ, the Hippocratea Family. Sepals five, very small, united up to the middle, persistent, with an imbricated æstivation. Petals five, with an imbricated æstivation. Stamens three, monadelphous; the united filaments forming a tube or a disk-like cup round the ovary; anthers with transverse dehiscence. Ovary free, trilocular; style one; stigmas one to three. Fruit consisting either of three samaroid carpels, or fleshy and one- to three-celled. Seeds definite, about four in each cell, attached to a central placenta, exalbuminous, anatropal, with a straight embryo, and flat, somewhat fleshy cotyledons. Arborescent or climbing shrubs, with opposite, simple, somewhat coriaceous leaves, having small deciduous stipules. They are found principally in South America; a few are natives of Africa and the East Indies. The fruit of some is eatable. Lindley mentions six genera, comprehending eighty-six species. Examples: Hippocratea, Salacia.

ORDER 185. MARCGRAAVIACEÆ, the Marcgravia Family. Sepals two to seven, usually coriaceous and persistent; æstivation imbricated. Corolla hypogynous, of five petals, or gamopetalous, calyptriform, entire or torn at the point. Stamens usually 00, very rarely five, hypogynous; filaments dilated at the base; anthers long, erect, introrse. Ovary single, unilocular; style one; stigma often capitate. Fruit coriaceous, indehiscent, or dehiscing by valves in a loculicidal manner, the placentas being parietal and forming spurious dissepiments. Seeds indefinite, minute, in a pulp, anatropal, exalbuminous; embryo straight. Trees and shrubs, with alternate, simple, entire, coriaceous, and exstipulate leaves. Flowers furnished occasionally with bracts, which are folded and united so as to form ascidia. They occur chiefly in the warmer parts of America. Their properties are scarcely known. There are four genera mentioned, and twenty-six species. Examples: Marcgraavia, Norantea.

ORDER 186. GUTTIFERÆ, or CLUSIACEÆ, the Gamboge Family. Sepals two to six, or eight, usually persistent, round, frequently unequal and colored;

æstivation imbricated. Petals hypogynous, equal to, or a multiple of, the sepals. Stamens hypogynous, usually 00, rarely definite, free or variously united at the base; filaments unequal in length; anthers adnate, introrse or extrorse, sometimes very small, occasionally unilocular, and sometimes with porous or circumscissile dehiscence. Thalamus, forming a fleshy, sometimes five-lobed disk. Ovary solitary, one- or many-celled; ovules either solitary and erect, or ascending and numerous, and attached to central placentas; style 0 or very short; stigmas peltate or radiate. Fruit dry or fleshy, one- or many-celled, one- or many-seeded, either with septicidal dehiscence or indehiscent. Seeds definite, anatropal, orthotropal, in a pulp, apterous, and often arillate, with a thin and membranous spermoderm; albumen 0; embryo straight; cotyledons usually cohering.

Trees or shrubs, sometimes parasitical, with exstipulate, opposite, coriaceous, entire leaves, having a strong midrib, and lateral veins running directly to the margin. Flowers articulated with the peduncle, often unisexual by abortion. They are natives of tropical regions, more especially of South America. Lindley enumerates 30 genera, including 150 species. *Tribe* 1. *Clusieæ*. Ovary many-celled, one- or many-seeded. Fruit capsular. Example: *Clusia. *Tribe* 2. *Moronobeæ*. Ovary many-celled, the cells many-seeded. Fruit fleshy, indehiscent. Example: Chrysopia. *Tribe* 3. *Garcinieæ*. Ovary many-celled, the cells one-seeded. Fruit fleshy. Examples: Mammea, Garcinea, Cambogia. *Tribe* 4. *Calophylleæ*. Cells of ovary two, with two seeds, or one cell with one to three seeds. Fruit capsular or drupaceous. Example: Mesua.

Garcinia cambogia, a Malabar tree, furnishes gamboge. G. mangostena supplies the East Indian Mangosteen fruit. The Mammee apple of South America is derived from Mammea americana. A species of Clusia is found in Florida.

Carcinia cambogia, the Gamboge tree (*pl.* 67, *fig.* 4); *a*, a flowering branch; *b*, the fruit; *c*, cross-section; *d*, flower; *e*, pistil in section; *f*, a seed.

ORDER 187. HYPERICACEÆ, the St. John's Wort Family. Sepals four or five, separate or united, persistent, usually with glandular dots, unequal; æstivation imbricated. Petals four or five, oblique, often with black dots; æstivation contorted. Stamens hypogynous, ∞, generally polyadelphous, very rarely ten, and monadelphous or distinct; filaments filiform; anthers bilocular, with longitudinal dehiscence; carpels two to five, united round a central or basal placenta; styles the same in number as the carpels, usually separate; stigmas capitate or simple. Fruit either fleshy or capsular, multilocular and multivalvular, rarely unilocular. Seeds usually 00, minute, anatropal, usually exalbuminous; embryo usually straight. Herbaceous plants, shrubs, or trees, with exstipulate, entire leaves, which are usually opposite and dotted. Flowers often yellow. They are distributed very generally over all parts of the globe, are found in elevated and low, dry and damp situations. They yield a resinous colored juice, which has purgative properties, and resembles gamboge. Lindley places Parnassia in this order. There are 15 known genera, and about 270 species. North America has

three genera and thirty-three species. *Tribe* 1. *Hypericeæ.* No glands between the stamens. Examples: *Hypericum, *Asyrum. *Tribe* 2. *Elodeæ.* Glands or scales alternating with the groups of stamens. Example: *Elodea.

Hypericum perforatum is the noxious yellow flowered plant, called St. John's Wort, and common in old fields and pastures.

Hypericum perforatum (*pl.* 67, *fig.* 3); *a*, flowering branch; *b*, calyx; *c*, fruit; *d*, lower half of a leaf magnified.

Order 188. Aurantiaceæ, the Orange Family. Calyx urceolate or campanulate, short, three- to five-toothed, withering. Petals three to five, broad at the base, sometimes slightly coherent; æstivation imbricated. Stamens equal in number to, or a multiple of, the petals; filaments flattened at the base, distinct or combined into one or more parcels; anthers erect. Thalamus enlarged in the form of a hypogynous disk, to which the petals and stamens are attached. Ovary free, multilocular; style one; stigma thickish, somewhat divided. Fruit a hesperidium, having a spongy, separable rind, and pulpy, separable cells. Seeds anatropal, attached to the axis, solitary, or several, usually pendulous, having the chalaza and raphe usually well marked; perisperm 0; embryo straight; cotyledons thick and fleshy. Trees or shrubs, usually conspicuous for their beauty, with alternate, often compound leaves, which are articulated with a usually winged petiole. They abound in the East Indies. There are twenty genera and nearly one hundred species enumerated. *Tribe* 1. *Limoneæ.* Stamens twice as many as the petals. One ovule only, or two collateral. Example: *Limonia. *Tribe* 2. *Clauseneæ.* Stamens twice as many as the petals. Ovules two, superimposed. Example: Marraya. *Tribe* 3. *Citreæ.* Stamens double or multiple the petals in number. Ovules many, in two series. Examples: Feronia, Citrus.

Plants of this order are characterized by having receptacles of volatile oil in almost every part. It includes the Orange, Lemon, Lime, Citron, Shaddock, &c. Citrus vulgaris yields the bitter or Seville orange. Sweet oranges are derived from Citrus aurantium. The best come from the Azores. A single tree has been known to produce 20,000 oranges. Citrus limonum supplies the Lemon; C. medica, the Citron; C. limetta, the Lime; C. decumana, the Shaddock. Oil of Bergamot is the volatile oil from the rind of the Bergamot, a variety of the Lime. Extensive groves of Orange trees are found in East Florida, south of latitude 29° 30′.

Citrus medica, the Citron (*pl.* 67, *fig.* 5); *a*, a flowering branch; *b*, stamens; *c*, a single bundle of stamens; *d*, anther; *e*, pistil; *f*, cross-section of fruit; *g*, *h*, seed.

Order 189. Olacaceæ, the Olax Family. Calyx small, gamosepalous, entire or toothed, often becoming finally large and fleshy; æstivation imbricated. Petals three to six, hypogynous, free, or adhering in pairs by means of the stamens; æstivation valvate. Stamens hypogynous, some fertile, others sterile; the former three to ten, alternate with the petals, the latter opposite to the petals; filaments compressed; anthers innate, bilocular, with longitudinal dehiscence. Ovary one- to three- or four-celled;

ovules one to three, pendulous from a central placenta; style filiform; stigma simple. Fruit fleshy, indehiscent, often surrounded by the enlarged calyx, unilocular, monospermal. Seed anatropal, pendulous; albumen copious, fleshy; embryo small, at the base of the albumen. Trees or shrubs, with simple, alternate, exstipulate leaves, which are, however, sometimes abortive. They are chiefly tropical or sub-tropical. Little is known in regard to their properties. There are twenty-four genera and fifty-three species enumerated. Examples: Olax, Opilia.

ORDER 190. TERNSTRŒMIACEÆ, the Tea Family. Sepals five or seven, concave, coriaceous, deciduous, the innermost often the largest; æstivation imbricated. Petals five, six, or nine, often combined at the base. Stamens indefinite, hypogynous; filaments free, or united at the base in one or more parcels; anthers versatile or adnate, dehiscing longitudinally. Ovary multilocular; styles two to seven. Fruit either a capsule, two- to seven-celled, opening by valves, or coriaceous and indehiscent. Seeds attached to the axis, few and large; albumen 0, or in very small quantity; embryo straight, or bent, or folded back; radicle next the hilum; cotyledons very large, often containing oil. Trees or shrubs, with alternate, coriaceous, exstipulate leaves, which are sometimes dotted. They abound in South America, and many occur in India, while others inhabit China and North America. There are 33 genera and 130 species enumerated. Examples: Ternstrœmia, *Gordonia, Camellia, Thea, *Stuartia.

Species of Thea (T. viridis and bohea) furnish most of the Chinese teas. It is a matter of some uncertainty whether black and green teas are derived from different species or not. Green teas contain more essential oil and tannin than black. The principal varieties of the former are Twankay, Young Hyson, Hyson, Gunpowder, and Imperial; the latter include Bohea, Congou, Souchong, Oolong, and Pekoe. Perfume is communicated to teas by the flowers of Olea fragrans, Cloranthus inconspicuus, and Aglaia odorata. The highly ornamental Camellia japonica is a member of the order.

Thea chinensis, Tea plant (*pl.* 67, *fig.* 6); *a*, *b*, *c*, three varieties; *d*, pistil and one stamen; *e*, *f*, *g*, ovary.

Camellia japonica (Japan) (*pl.* 68, *fig.* 14); *a*, branch with a flower; *b*, two stamens; *c*, pistil; *d*, cross-section of capsule; *e*, section of seed.

ORDER 191. CHLÆNACEÆ. Involucre one- to two-flowered, persistent. Sepals three, small. Petals five to six, hypogynous, sometimes combined at the base, where they are broader. Stamens ten, or indefinite; filaments cohering at the base, and united to the base of the petals; anthers roundish, free or united, bilocular. Ovary single, trilocular; style one, filiform; stigma trifid. Capsule three-celled, or by abortion one-celled. Seeds solitary or numerous, suspended, attached to a central placenta; embryo in the axis of fleshy or horny albumen; cotyledons leafy, undulated. Trees or shrubs, with alternate stipulate leaves, found in Madagascar. Their properties are unknown. There are four genera enumerated, including probably about eight or ten species. Examples: Sarcolæna, Leptolæna.

ORDER 192. DIPTEROCARPACEÆ, the Sumatra Camphor Family. Calyx

tubular, five-lobed, unequal, naked, persistent, and afterwards enlarged, with an imbricated æstivation. Petals hypogynous, sessile, often combined at the base, with a twisted æstivation. Stamens indefinite, hypogynous; filaments dilated at the base, either distinct or irregularly cohering; anthers innate, bilocular, subulate, opening by terminal fissures. Torus not enlarged in a disk-like manner. Ovary superior, three-celled; ovules in pairs, pendulous; style and stigma simple. Fruit coriaceous, unilocular by abortion, three-valved or indehiscent, surrounded by the calyx, which is prolonged in the form of long wing-like lobes. Seed solitary, exalbuminous; cotyledons often twisted and crumpled; radicle superior. Trees with alternate leaves, having an involute vernation, and deciduous convolute stipules. They are found in India. There are about eight known genera, including forty-eight species. Examples: Dipterocarpus, Vateria, Dryobalanops.

ORDER 193. TILIACEÆ, the Linden Family. Sepals four to five, with a valvate æstivation. Petals four to five, entire, rarely wanting. Stamens hypogynous, free, or united by the enlarged border of the stalk of the pistil, usually ∞; anthers two-celled, dehiscing longitudinally or by pores, occasionally some abortive. Disk often large and glandular. Ovary solitary, formed by the union of two to ten carpels; style one; stigmas as many as the carpels. Fruit dry or pulpy, either multilocular with numerous seeds, or by abortion unilocular and one-seeded. Seeds anatropal; embryo erect in the axis of fleshy albumen, with flat, leafy cotyledons. Trees or shrubs, rarely herbaceous plants, with alternate stipulate leaves. They are found chiefly in tropical regions, only a small number inhabiting northern countries. The order has been divided into two sections: 1. Tilieæ, with entire petals or 0, and anthers dehiscing longitudinally. 2. Elæocarpeæ, with lacerated petals, and anthers opening at the apex. Lindley enumerates thirty-five genera, including 350 species. Examples: *Tilia, *Corchorus, Grewia, Aristotelia, Elæocarpus. Five species of the two first-named genera are the North American representatives. Species of Tilia are known as Linden or Lime trees. Russian mats are made from the inner bark of the Tilia europæa.

Tilia grandiflora, Lime tree or Linden (*pl.* 68, *fig.* 6); *a–h*.

ORDER 194. BYTTNERIACEÆ, the Chocolate Family. Calyx four- to five-lobed, valvate in æstivation. Petals four to five or 0, often elongated at the apex, with a twisted or induplicate æstivation. Stamens hypogynous, either equal in number to the petals, or some multiple of them, more or less monadelphous, some of them sterile; anthers bilocular, introrse. Ovary free, composed usually of four to ten carpels arranged round a central column; styles terminal, as many as the carpels, free or united; ovules two in each loculament. Fruit capsular, either with loculicidal dehiscence, or the carpels separating from each other. Seeds anatropal, often winged; embryo straight or curved, lying usually in fleshy albumen; cotyledons either plaited or rolled up spirally. Trees, shrubs, or undershrubs, with alternate leaves, having either deciduous stipules or 0, and stellate or forked hairs. They abound in tropical climates. Lindley enumerates forty-five

genera, embracing four hundred species. *Tribe* 1. *Lasiopetaleæ.* Calyx petaloid. Petals reduced to short scales or 0. Five anthers bearing filaments, alternating with an equal number of abortive ones. Embryo straight with foliaceous cotyledons, in a thick perisperm. Species Australasian. Example: Seringia. *Tribe* 2. *Byttnerieæ.* Petals concave or vaulted, often prolonged at the apex into a liguliform appendage. Staminal tube divided superiorly into ten strips alternately sterile and carrying one to three anthers. Embryo with cotyledons sometimes foliaceous in a thick albumen, sometimes folded or convolute without perisperm. Species belong to both worlds. Example: Theobroma, Telfairia. *Tribe* 3. *Hermannieæ.* Petals flat. Five monadelphous fertile stamens. Embryo with foliaceous cotyledons, straight or arched in a fleshy albumen. Plants common to both continents, especially abundant in South Africa. Example: *Melochia, Waltheria. *Tribe* 4. *Dombeyaceæ.* Petals flat. Stamens fifteen to forty, those opposite the petals usually sterile and liguliform. Embryo with foliaceous cotyledons, often bifid and folded, in a thin perisperm. Example: Kydia. *Tribe* 5. *Eriolaenieæ.* Petals flat. Stamens numerous, all anther bearing, united into one column. Embryo with the cotyledons folded, bilobed, in a fleshy perisperm. Species Asiatic. Example: Schillera.

The only North American representatives of the order are Melochia pyramidata and Hermannia texana, found in Texas. The most conspicuous species is the Chocolate tree, Theobroma cacao. Chocolate consists of the roasted and ground beans mixed with sugar, arnotto, vanilla, and cinnamon. Butter of cacao is a fatty oil obtained by expression from the seed.

Theobroma cacao, the Cacao or Chocolate tree (South America) (*pl.* 67, *fig.* 12); *a*, a flower branch and a branch with fruit; *b*, vertical section of the latter; *c*, flower; *d*, stamen; *e*, staminal tube; *f*, pistil; *g*, lower stamens; *h–l*, seeds.

Order 195. Sterculiaceæ, the Sterculia and Silk-cotton Family. Calyx of five, more or less united, sepals, often surrounded by an involucre; æstivation usually valvate. Petals five or none, hypogynous, æstivation twisted. Stamens usually ∞; their filaments variously united; anthers two-celled, extrorse. Pistil of five (rarely) three carpels, either distinct or cohering; styles equal in number to the carpels, free or cohering; ovules orthotropal or anatropal. Fruit capsular, usually with five cells, or follicular or succulent. Seeds often with a woolly covering; with a fleshy or oily perisperm (rarely 0), and either a straight or a curved embryo; cotyledons leafy or thick, plaited or rolled round the plumule. Trees or shrubs, with alternate leaves, which are either simple or compound, deciduous stipules, and often a stellate pubescence. They are distinguished from Malvaceæ by their dithecal extrorse anthers. They inhabit warm climates.

Sub-order 1. *Adansonieæ.* Flowers hermaphrodite. Anthers one-locular (sometimes germinate). Fruit sessile, most often with loculicidal dehiscence, rarely indehiscent. Perisperm usually almost wanting. Leaves digitate or palmate. Examples: Adansonia, Bombax, Cheirostemon, Montezuma.

Sub-order 2. *Helictereæ.* Flowers hermaphrodite. Anthers two-locular

(evident in the bud). Fruit stipitate. Perisperm fleshy and thick. Leaves simple. Example: Helicteres.

Sub-order 3. *Sterculieæ.* Flowers unisexual. Leaves simple or palmate. Example: Cola.

There are thirty-four genera and 125 species, none of which are North American. Adansonia digitata, the Baobab or Monkey bread of Senegal, is one of the largest of known trees, a diameter of thirty feet having been observed. Adanson incorrectly estimated the age of this individual at 5000 years. The height is not in proportion to the diameter. Cheirostemon platanoides is the Mexican Hand plant, so called on account of the five peculiarly curved anthers, resembling claws. The silky hairs of Bombax ceiba, the silk-cotton tree, are used in stuffing cushions.

ORDER 196. MALVACEÆ, the Mallow Family. Sepals five, rarely three or four, more or less cohering at the base, with a valvate æstivation, often bearing an external calyx (epicalyx) or involucre. Petals equal in number to the sepals; æstivation twisted. Stamens 00, hypogynous, all perfect; filaments monadelphous or polyadelphous; anthers monothecal, reniform, with transverse dehiscence. Ovary formed by the union of several carpels round a common axis, either distinct or cohering; styles as many as the carpels, united or free. Fruit capsular or baccate; carpels one- or many-seeded, sometimes closely united, at other times separate or separable; dehiscence loculicidal or septicidal. Seeds amphitropal or semi-anatropal; albumen 0, or in very small quantity; embryo curved; cotyledons twisted or doubled. Herbaceous plants, trees, or shrubs, with alternate stipulate leaves, more or less divided, and often with stellate hairs. They are found chiefly in tropical countries and in the warm parts of the Temperate Zone.

Tribe 1. *Malopeæ.* Carpels indefinite, crowned together in a five-lobed or amorphous head, uniovulate. Radicle inferior. None North American. Example: Malope.

Tribe 2. *Malveæ.* Carpels as many as the stigmas (five to twenty or more), uniovulate or pauciovulate, disposed in a ring around a central axis, from which they at length separate. Column antheriferous at the summit. *Sub-tribe* 1. *Eumalveæ.* Style stigmatose down the inner face. Carpels uniovulate, numerous. Ovule peritropous, ascending. Examples: *Malva, *Callirrhöe, *Napæa. *Sub-tribe* 2. *Sideæ.* Stigmas terminal, capitate. Carpels uniovulate. Example: *Sida. *Sub-tribe* 3. *Abutileæ.* Carpels three- to nine-ovulate, not bilocellate, somewhat two-valved, scarcely separating from the axis. Example: *Abutilon.

Tribe 3. *Ureneæ.* Carpels or cells of the ovary half as many as the stigmas (viz. five, the stigmas ten), uniovulate. Radicle inferior. Examples: Urena, *Malachra.

Tribe 4. *Hibisceæ.* Carpels as many as the stigmas, three to ten (usually five), combined into a loculicidal few- or many-seeded (or rarely indehiscent) capsule; the dissepiments borne on the middle of the valves. Column antheriferous for a great part of its length, naked and five-toothed at the apex. Examples: *Hibiscus, Gossypium, Abelmoschus.

Lindley enumerates 37 genera with 1000 species. North America has

eleven genera and fifty-three species. All the species yield mucilage in large quantity, and none are poisonous. The Hollyhock, Althœa rosea, is an ornamental plant, as are many other species. The Sun-hemp of India is derived from Hibiscus esculentus. Okra, a substance much used in soups, is the fruit of Abelmoschus esculentus. Various species of Gossypium furnish cotton, which consists of the hairs surrounding the seed. These, when dry, exhibit to the microscope a peculiar twisted appearance, by which they are readily recognised. The Sea Island, New Orleans, and Georgia cottons, considered the best, are obtained from G. barbadense. G. acuminatum furnishes the South American cotton; G. arboreum, the Indian tree cotton; G. nanking, nankeen cotton. The nankeen color is said to be imparted by the fruit of Acacia arabica.

Gossypium herbaceum, Cotton plant (*pl.* 67, *fig.* 11); *a*, a flowering branch, and *a* (to the right hand), a flower; *b*, capsule with the calyx; *c*, capsule; *d*, germs; *e*, cross-section of the capsules; *f*, seeds with the cotton hairs; *g–m*, seeds with the embryo.

ORDER 197. VIVIANIACEÆ, the Viviania Family. Sepals five, united. Petals five, hypogynous, unguiculate, persistent, with twisted æstivation. Stamens ten, hypogynous; filaments free; anthers bilocular, opening longitudinally. Ovary free, three-celled; stigmas three. Capsule three-celled, three-valved, loculicidal; seeds, two in each cell, with a curved embryo lying in fleshy albumen. Herbaceous or suffruticose plants, with opposite or verticillate exstipulate leaves. Natives of South America, having no properties of importance. Genera four, species fifteen. Examples: Viviania, Cæsarea.

ORDER 198. CARYOPHYLLACEÆ, the Chickweed Family. Sepals four or five, free, or united in a tube, persistent. Petals four to five, hypogynous, unguiculate, often bifid or bipartite, occasionally 0. Stamens usually double the number of the petals, or, if equal, usually alternate with them: filaments subulate, sometimes united; anthers innate, bilocular, dehiscence longitudinal. Ovary single, often stalked or supported on a gynophore composed of two to five carpels, which are usually united by their edges, but sometimes the edges are turned inwards, so as to form partial dissepiments; stigmas two to five, with papillæ on their inner surface. Capsule unilocular, or imperfectly bi-quinquelocular, two- to five-valved, opening either by valves, or more commonly by twice as many teeth as stigmas; placenta in the axis of the fruit. Seeds usually 00, amphitropal, with mealy albumen, and a peripherical embryo. Herbs, sometimes suffruticose plants, with opposite, entire, exstipulate, sometimes connate leaves, and usually cymose inflorescence. They inhabit chiefly temperate and cold regions. Lindley mentions 53 genera and 1055 species, of which 11 genera and upwards of 100 species belong to the United States.

Sub-order 1. *Alsineæ.* Sepals nearly or quite distinct. Petals sessile. Examples: *Mollugo, *Arenaria, *Stellaria, *Cerastium.

Sub-order 2. *Sileneæ.* Sepals united into a cylindrical tube. Petals unguiculate. Examples: *Silene, *Lychnis, *Saponaria, *Dianthus.

Some authors separate a third sub-order, Molugineæ, from Alsineæ, with

the sepals alternate with the stamens, when isostemonous, instead of opposite, as in the restricted Alsineæ. Some plants of the order are poisonous. A prominent species is Dianthus caryophyllus, or Carnation, in its different varieties.

Dianthus caryophyllus, Carnation (*pl.* 68, *fig.* 11); *a*, *b*.

Saponaria officinalis, Soapwort (*pl.* 68, *fig.* 12); *a*, a flowering branch: *b*, pistil and petal; *c*, pistil; *d*, capsule; *e–g*, seed.

ORDER 198. ELATINACEÆ, the Water-pepper Family. Sepals three to five, free, or slightly coherent at the base. Petals alternate with the sepals, hypogynous. Stamens hypogynous, equal to, or twice as many as, the petals. Ovary tri-quinquelocular; styles three to five; stigmas capitate. Fruit capsular, three- to five-celled, three- to five-valved, loculicidal: placenta central. Seeds 00, exalbuminous, anatropal; embryo cylindrical and slightly curved. Annual marsh plants, with hollow creeping stems, and opposite stipulate leaves. They are found in all parts of the globe. Some of them have acridity, and hence the name Water-pepper. Genera six and species twenty-two, according to Lindley. Examples: *Elatine, Bergia. Elatine with two species are North American.

ORDER 199. FRANKENIACEÆ, the Frankenia Family. Sepals four or five, cohering into a tube, persistent. Petals four to five, alternate with the sepals, hypogynous. Stamens hypogynous, equal in number to the petals, and alternate with them, sometimes more numerous; anthers bilocular, with longitudinal dehiscence. Ovary unilocular, with parietal placentas; style filiform, often trifid. Fruit a one-celled, usually three-valved capsule, with septicidal dehiscence. Seeds very minute, numerous, anatropal; embryo straight, in the axis of fleshy albumen. Herbs or undershrubs, with opposite, exstipulate leaves. They are found chiefly in the southern parts of Europe, in western America, and in the north of Europe. They are said to have mucilaginous and slightly aromatic properties. Genera four, species twenty-four. Example: *Frankenia. F. grandifolia, a Californian plant, is North American.

ORDER 200. TAMARICACEÆ, the Tamarisk Family. Calyx four- or five-partite, persistent, with imbricated æstivation. Petals four to five, hypogynous, or perhaps inserted at the base of the calyx, marcescent, with imbricated æstivation. Stamens hypogynous, free, or monadelphous, equal to the petals in number, or twice as many; anthers dithecal, introrse, with longitudinal dehiscence. Ovary unilocular; styles three. Fruit a three-valved, one-celled capsule, with loculicidal dehiscence. Seeds numerous, anatropal, erect or ascending, comose; albumen 0; embryo straight, with the radicle next the hilum. Shrubs or herbs, with alternate scale-like leaves, and racemose or spiked flowers. They abound in the Mediterranean region, and are confined chiefly to the eastern half of the northern hemisphere. Many are found in the vicinity of the sea. They have a bitter astringent bark, and some of them yield a quantity of sulphate of soda when burned. The saccharine substance called Mount Sinai Manna is yielded by Tamarix mannifera. Lindley mentions three genera, comprising forty-three known species. Examples: Tamarix, Myricaria.

Tamarix germanica, Tamarisk (*pl.* 69, *fig.* 4); *a*, flowering branch; *b*, flower; *c*, sexual apparatus; *d*, staminal tube displayed; *e*, anther; *f*, petal; *g*, pistil; *h*, the fruit in the calyx; *i*, a single fruit; *k*, vertical section of ditto.

Order 201. Tremandraceæ, the Porewort Family. Sepals four or five, slightly coherent, deciduous with a valvate æstivation. Petals four or five, deciduous, with an involute æstivation. Stamens hypogynous, distinct, eight to ten, two before each petal; anthers di- or tetra-thecal, with porous dehiscence. Ovary bilocular, with one to three pendulous ovules in each cell; style one; stigmas one or two. Fruit a two-celled, two-valved capsule, with loculicidal dehiscence. Seeds anatropal, pendulous, with a caruncula at the apex; embryo cylindrical, straight, in the axis of fleshy albumen. Heath-like shrubs, with hairs usually glandular, alternate, or verticillate exstipulate leaves, and solitary, axillary, one-flowered pedicels. They are natives of New Holland. Nothing is known regarding their properties. Lindley mentions three genera including sixteen species. Examples: Tetratheca, Tremandra.

Order 202. Polygalaceæ, the Milkwort Family. Sepals five, very irregular, distinct; three exterior, of which one is superior and two inferior; two interior, usually petaloid lateral; æstivation imbricated. Petals hypogynous, unequal, usually three, of which one is anterior, and larger than the rest, and two are alternate with the upper and lateral sepals; sometimes there are five petals, two of them very minute; the anterior petal, called the keel, is often crested. Stamens hypogynous, eight, monadelphous or diadelphous; anthers clavate, usually one-celled, and having porous dehiscence. Ovary mostly bilocular; ovules solitary, rarely two; style simple, curved; stigma simple. Fruit dehiscing in a loculicidal manner, or indehiscent. Seeds pendulous, anatropal, strophiolate at the hilum; albumen fleshy; embryo straight. Shrubs or herbs with alternate or opposite exstipulate leaves. They are found in all quarters of the globe. Lindley mentions nineteen genera, including 495 species. Examples: *Polygala, Securidaca, *Krameria, Xantophyllum. Of these genera Polygala with twenty-four species, and Krameria with four, are natives of North America. Some authors place Krameria and Xantophyllum in a separate sub-order (Kramerieæ). Plants of the order Polygalaceæ have some resemblance to Papilionaceæ, but may be distinguished by the odd petal being inferior and the sepal superior. Polygala senega, the Seneca snake root, is a plant of various medicinal applications.

Order 203. Droseraceæ, the Sundew Family. Sepals five, persistent, equal, sometimes united at the base, imbricated in æstivation. Petals five, alternate with the sepals, nearly or quite hypogynous, marcescent. Stamens distinct, marcescent, usually as many as the petals and alternate with them, rarely two to three times as many; filaments capillary or flattened; anthers extrorse or innate; cells distinct, or somewhat connivent above, opening longitudinally, or rarely by a terminal pore. Ovary composed of two to five united carpels, one-celled; placentas parietal, or filling the base of the cell; styles two to five, usually distinct or united at the base merely, each

two-parted or multifid and pencil-shaped; sometimes all united into one. Capsule two- to five-valved, loculicidal, with the valves placentiferous in the middle, or indehiscent with the placenta at the base, many- (rarely few-) seeded. Seeds anatropous; testa sometimes arilliform. Embryo short, at the base of cartilaginous or fleshy albumen. Herbs, or rarely suffrutescent plants (growing in wet places or swamps). Leaves alternate or crowded, entire, commonly furnished with glandular hairs, with a circinate vernation (except Dionæa); stipules none, or in the form of a tuft or fringe of scarious hairs at the base of the petioles. There are eight genera, with about ninety species, of which three genera and thirteen species are North American. *Tribe* 1. *Drosereæ.* Seeds with albumen. Styles one or many. All the stamens fertile. Examples: *Drosera, *Dionæa. *Tribe* 2. *Parnassieæ.* No albumen. Stigmata sessile. Some of the stamens sterile. No glandular hairs. Example: *Parnassia. The most remarkable species of the order is Dionæa muscipula or Venus' Fly-trap, a plant only found within a limited district in North and South Carolina. The two halves of the leaf are articulated on the midrib, and have a fringe of stiff hairs which interlace when the leaf is folded. Each half is furnished with two or three irritable hairs, which, when touched by an insect, cause the sudden closing of the leaf and the consequent impalement or imprisonment of the intruder. Species of Parnassia are known as Grass of Parnassus.

Order 204. Violaceæ, the Violet Family. Sepals five, persistent, usually elongated at the base, æstivation imbricated. Petals five, hypogynous, equal or unequal, generally withering, æstivation obliquely convolute. Stamens five, alternate with the petals, sometimes opposite to them, inserted on a hypogynous torus; anthers dithecal, introrse, often cohering, with a prolonged connective sometimes spurred; filaments dilated, two of them in the irregular flowers having an appendage at their base. Ovary unilocular, with many (rarely one) anatropal ovules; style single, usually declinate, with an oblique hooded stigma. Fruit a three-valved capsule, dehiscence loculicidal, placentas on the middle of the valves. Seeds 00 or definite; embryo straight, erect, in the axis of a fleshy perisperm. Herbs or shrubs, with alternate, rarely opposite leaves, having persistent stipules, and an involute vernation. They are natives of Europe, Asia, and America. The herbaceous species inhabit chiefly the temperate parts of the northern hemisphere, while the shrubby species are found in South America and India. They have been divided into two sub-orders:

Sub-order 1. *Violeæ*, with irregular flowers.

Sub-order 2. *Alsodeieæ*, with regular flowers. There are fourteen known genera, and 315 species. Examples: *Viola, *Ionidium, Alsodeia, *Solea. North America possesses three genera, and about forty species. Viola tricolor is the origin of the varieties of Pansy and Heart's Ease.

Order 205. Cistaceæ, the Rock-Rose Family. Sepals usually five, persistent, unequal, the three inner with contorted æstivation. Petals five, caducous, hypogynous, æstivation corrugated, and twisted in an opposite direction to that of the sepals. Stamens usually 00, free, hypogynous; anthers two-celled, adnate. Ovary syncarpous, one- or many-celled; style

single; stigma simple. Fruit capsular, three-, five-, to ten-valved, either one-celled or imperfectly five- to ten-celled, with loculicidal dehiscence. Seeds usually indefinite; embryo inverted, either spiral or curved, in the midst of mealy albumen; radicle remote from the hilum. Shrubs or herbaceous plants with entire, opposite or alternate, stipulate or exstipulate leaves. They inhabit chiefly the southern regions of Europe, and the north of Africa. Some of the species are remarkable for the irritability of their stamens. Many of them yield a resinous balsamic juice, which imparts viscidity to the branches. The resinous matter called ladanum or labdanum, is yielded by Cistus creticus. Of the seven genera and 185 species which are assigned to Cistaceæ, North America has twelve species, and three genera.

Helianthemum vulgare (Europe) (*pl.* 68, *fig.* 8); *b*, the red flowering variety.

ORDER 206. FLACOURTIACEÆ, the Arnotto Family. Sepals four to seven, slightly cohering. Petals equal to and alternating with the sepals, or wanting. Stamens hypogynous, equal in number to the petals, or some multiple of them. Ovary roundish, sessile, or slightly stalked; style either none or filiform; stigmas several, more or less distinct; ovules attached to parietal placentas, which sometimes branch all over the inner surface of the valves. Fruit one-celled, containing a thin pulp, either fleshy and indehiscent, or capsular with four or five valves. Seeds numerous, enveloped in a covering formed by the withered pulp; albumen fleshy, somewhat oily; embryo axile, straight; radicle turned towards the hilum; cotyledons flat, foliaceous. Shrubs or small trees, with alternate, simple, usually exstipulate leaves, which are often dotted. The plants are chiefly natives of the warmest parts of the East and West Indies, and of Africa.

Sub-order 1. *Flacourtianeæ.* Placentas ramifying over the inner surface of the fruit. *Tribe* 1. *Flacourtieæ.* Fruit dehiscent. Example: Flacourtia. *Tribe* 2. *Erythrospermeæ.* Fruit indehiscent. Example: Erythrospermum.

Sub-order 2. *Bixaceæ.* Placentas narrow and running in lines along the parietes. *Tribe* 3. *Bixieæ.* Fruit dehiscent. Flowers hermaphrodite. Example: Bixa. *Tribe* 4. *Carpotrocheæ.* Fruit indehiscent. Flowers often unisexual. Example: Carpotroche.

The entire order embraces thirty-one genera and eighty-five species, none of them North American. The most important is Bixa orellana, the plant yielding arnotto. This is the reddish pulp surrounding the seeds, and is used to color cheese, and for various red dyes.

Bixa orellana, Arnotto tree (South America) (*pl.* 68, *fig.* 7); *a*, a flowering branch; *b*, anther; *c*, pistil; *d*, *e*, capsule in verticle and cross-section; *f*, burst capsule.

ORDER 207. RESEDACEÆ, the Mignonette Family. Calyx many-parted. Petals four to six, unequal, entire, or lacerated, in the latter case consisting of a broad scale-like claw, with a much-divided limb. Stamens ten to twenty-four, hypogynous, attached to a glandular torus; filaments variously united; anthers bilocular, innate, with longitudinal dehiscence. Ovary sessile, three-lobed, one-celled, multiovular, with three to six parietal

placentas; stigmas three. Fruit either a unilocular, many-seeded capsule, opening at the apex, so as to render the seeds seminude, or three to six few-seeded follicles. Seeds reniform, usually exalbuminous; embryo curved; radicle superior; cotyledons fleshy. Herbaceous plants, rarely shrubs, with alternate, entire, or divided leaves, having gland-like stipules. They inhabit chiefly Europe and the adjoining parts of Asia. A few are found in the north of India and south of Africa. The uses of the order are unimportant. Reseda luteola, Weld, yields a yellow dye. Reseda odorata is the fragrant Mignonette. The Mignonette is rendered suffruticose by preventing the development of its blossoms. This is the origin of the tree Mignonette, which is much cultivated in France. There are six known genera and forty-one species, according to Lindley. Example: Reseda. Ellimia ruderalis of California appears to be the only American representative.

Reseda luteola, Weld, or Dyer's rocket, Europe (*pl.* 66, *fig.* 13); *a*, *b*, flowers and leaf; *c*, flower; *e*, capsule; *f*, seed; *g*, flower from above.

Order 208. Capparidaceæ, the Caper Family. Sepals four, often more or less cohering. Petals four, sometimes 0, cruciate, usually unguiculate and unequal. Stamens hypogynous, four to six, or 00, but in general some high multiple of four, placed in an elongated hemispherical and often glandular torus. Ovary usually stalked; style filiform, sometimes 0; ovules curved. Fruit unilocular, siliquæform, and dehiscent, or fleshy and indehiscent, rarely monospermous, usually with two polyspermous placentas. Seeds generally reniform and exalbuminous; embryo curved; cotyledons foliaceous, flattish. Herbs, shrubs, sometimes trees, with alternate, stalked, undivided, or palmate leaves, which are either exstipulate or have spines at their base. They are found chiefly in warm countries, and are abundant in Africa. There are 28 genera and 340 species. Six genera and eleven species are natives of North America. *Tribe* 1. *Cleomeæ.* Fruit capsular. Examples: *Cleome, *Polanisia. *Tribe* 2. *Cappareæ.* Fruit fleshy. Example: Capparis. Not found in North America.

The flower buds of Capparis spinosa, a native of the south of Europe, furnish capers. This plant is supposed to be the Hyssop of the Scriptures.

Capparis spinosa, Caper plant (*pl.* 66, *fig.* 12); *a*, flowering branch; *b*, capsule; *c*, cross-section of ditto; *d*, seed.

Order 209. Cruciferæ, the Cruciferous, or Creswort Family. Brassicaceæ of Lindley. Sepals four, deciduous, the two latter ones gibbous at the base. Petals four, hypogynous, alternating with the sepals, deciduous, cruciate. Stamens six, tetradynamous, two shorter, solitary, opposite the lateral sepals, occasionally toothed; four longer, opposite the anterior and posterior sepals, generally free, sometimes partially united and furnished with a tooth on the inside; anthers bilocular, introrse. Torus with green glands between the petals and stamens and ovary. Ovary superior, with parietal placentas, which meet in the middle, forming a spurious dissepiment or replum; stigmas two, opposite the placentas, or anterior and posterior. Fruit a siliqua, or a silicula, rarely one-celled and indehiscent, usually

spuriously two-celled and dehiscing by two valves, which separate from the replum, one- or many-seeded. Seeds campylotropous, pendulous, attached in a single row by a funiculus to each side of the placentas; perisperm none; embryo with the radicle folded upon the cotyledons which are next the placenta. Herbaceous plants, seldom undershrubs, with alternate leaves, and yellow or white, rarely purple flowers, without bracts. This order is well distinguished by having tetradynamous stamens. Most of the plants belonging to the order are European. The species, however, are found scattered all over the world.

Sub-order 1. *Pleurorhizeæ.* Cotyledons accumbent. Radicle lateral. *Tribe* 1. *Arabideæ.* Siliquose. Cotyledons plane, parallel with the straight septum, linear. Examples: *Cheiranthus, *Nasturtium, *Arabis. *Tribe* 2. *Alyssineæ.* Silicules separating in two plane or concave valves. Cotyledons plane, parallel with the large and oval septum. Example: *Draba. *Tribe* 3. *Thlaspideæ.* Silicules separating in two navicular valves. Cotyledons plane, perpendicular to the straight septum. Example: *Thlaspi. *Tribe* 4. *Euclideæ.* Silicula indehiscent. Cotyledons plane, parallel with the septum, which is sometimes wanting. Example: Euclidium. *Tribe* 5. *Anastaticeæ.* Silicula longitudinally dehiscent, crossed by many transverse septa. Cotyledons plane, parallel with the septum. Example: Morettia. *Tribe* 6. *Cakilineæ.* Silicula lomentaceous. Cotyledons plane, parallel with the septum, when present. Example: Cakile.

Sub-order 2. *Notorhizeæ.* Cotyledons incumbent; radicle dorsal. *Tribe* 7. *Sisymbrieæ.* Siliquose. Cotyledons plane, perpendicular to the septum. Example: *Sisymbrium. *Tribe* 8. *Camelineæ.* Silicula separating into two concave valves. Cotyledons perpendicular to the elliptic septum, broader than high. Example: *Camelina. *Tribe* 9. *Lepidineæ.* Silicula separating into two navicular valves. Cotyledons parallel with the straight septum. Example: *Lepidium. *Tribe* 10. *Isatideæ.* Silicula indehiscent, one-locular, one-seeded. Examples: *Thysanocarpus, Isatis. *Tribe* 11. *Anchonieæ.* Siliqua or silicula lomentaceous. Example: Morisia.

Sub-order 3. *Orthoploceæ.* Cotyledons conduplicate; radicle dorsal. *Tribe* 12. *Brassiceæ.* Siliquose. Examples: Brassica, Sinapis. *Tribe* 13. *Velleæ.* Silicula separating into two concave valves. Septum elliptic. Example: Vella. *Tribe* 14. *Psychineæ.* Silicula separating into two navicular valves. Septum straight. Example: Schouwia. *Tribe* 15. *Zilleæ.* Silicula indehiscent, with one or two one-seeded cells. Example: Zilla. *Tribe* 16. *Raphaneæ.* Siliqua or silicula lomentaceous, the joints one- or few-seeded. Example: Raphanus.

Sub-order 4. *Spirolobeæ.* Cotyledons twice folded; radicle dorsal. *Tribe* 17. *Buniadeæ.* Silicula indehiscent, divided into four one-seeded cells by one longitudinal and one transverse septum. Example: Bunias. *Tribe* 18. *Erucarieæ.* Silicula lomentaceous, the lower joint two-celled, the upper one-celled. Example: Erucaria.

Sub-order 5. *Diplecolobeæ.* Cotyledons three times folded; radicle dorsal. *Tribe* 19. *Senebierieæ.* Silicula didymous, of two one-seeded cells. Example: Senebieria. *Tribe* 20. *Subularieæ.* Silicula separating

into two valves, septum elliptical, cells many-seeded. Example: Subularia. *Tribe* 21. *Heliophileæ.* Silicula elongated or oval, separating into two plane valves; septum straight or oval, cells many-seeded. Example: Heliophila.

The entire order includes about 173 genera, with 1600 species. Of these 40 genera and 240 species are North American. There are no truly poisonous plants in the order, the characteristics lying in the possession of anti-scorbutic and stimulant properties, with some acridity. Brassica oleracea is the stock from which all the varieties of cabbage are derived. B. rapa is the common turnip; B. campestris, the Swedish turnip. Sea-kale is Crambe maritima. The seeds of Sinapis nigra furnish table mustard; and of S. alba, white mustard. The Horse-radish is Cochlearia (Armoracia) rustica; Isatis tinctoria furnishes Woad; I. indigotica, Chinese Indigo. The Radish and Cress also belong here.

Sinapis alba, White Mustard (*pl.* 66, *fig.* 11); *a*, *b*, leaf, flowers, and fruit; *c*, sexual apparatus; *d*, siliqua; *e*, ditto opened; *f*, *g*, seed.

ORDER 210. FUMARIACEÆ, the Fumitory Family. Sepals two, deciduous. Petals four, cruciate; one or both of the two outer gibbous at the base, the two inner cohering at the apex. Stamens hypogynous, usually six, diadelphous; anther of middle stamen of each parcel bilocular, outer ones unilocular. Ovary free, one-celled; style filiform; stigma with two or more points; ovules amphitropal. Fruit either an achænium, or a two-valved, two-seeded capsule, or a many-seeded siliqua. Seeds crested; albumen fleshy; embryo minute, excentric. Herbaceous plants, with a watery juice, and alternate, multifid leaves. Although at the first sight very unlike the Poppy family, the Fumitories resemble this order in their deciduous sepals, in their seeds, and in many cases in their fruit. The two outer unilocular stamens of each parcel may be considered as forming one perfect stamen, thus making the whole number four. They are found chiefly in northern temperate latitudes. They are said to be bitter and diaphoretic in their properties. Lindley notices 15 genera, including 110 species. North America has four genera and twelve species. *Tribe* 1. *Corydaleæ.* Fruit siliquose, dehiscent, many-seeded. Examples: *Dielytra, *Adlumia, *Corydalis. *Tribe* 2. *Fumarieæ.* Fruit siliculose, indehiscent, many-seeded. Example: Fumaria.

Adlumia cirrhosa is the Alleghany vine of American gardens. Species of Dielytra are vulgarly known as Dutchman's Breeches.

ORDER 210. PAPAVERACEÆ, the Poppy Family. Sepals two, deciduous. Petals hypogynous, usually four, cruciate, sometimes a multiple of four, regular, rarely wanting. Stamens hypogynous, usually 00, sometimes a multiple of four; anthers dithecal, innate. Ovary solitary; style short or none; stigmas two, or many and radicating; ovules 00, anatropal. Fruit unilocular, either siliquæform with two, or capsular with several parietal placentas. Seeds numerous; albumen between fleshy and oily; embryo minute, at the base of the albumen, with plano-convex cotyledons. Herbs or shrubs, usually with milky or colored juice, having alternate exstipulate leaves, and long one-flowered peduncles. The plants belonging to this

order are chiefly European. The species, however, are found scattered over tropical America, Asia, China, New Holland, Cape of Good Hope, &c. Lindley mentions eighteen known genera, and 130 species. North America has eleven genera, including sixteen species.

Tribe 1. *Argemoneæ.* Juice milky, colored. *Sub-tribe* 1. *Bocconieæ.* Petals none, or not wrinkled in the bud. Examples: *Sanguinaria, Bocconia. *Sub-tribe* 2. *Papavereæ.* Petals large, wrinkled in the bud. Examples: Chelidonium, *Argemone, *Papaver.

Tribe 2. *Eschscholtzieæ.* Juice watery. *Sub-tribe* 3. *Hunemannieæ.* Capsule bivalve. Examples: Eschscholtzia, *Dendromecon. *Sub-tribe* 4. *Platystemoneæ.* Examples: Platystemon, *Meconella.

Opium is the concrete milky juice from the unripe capsules of Papaver somniferum, or Poppy and its varieties. This plant is indigenous in western Asia, but has become extensively distributed in other parts of the world. The principal active principle of opium is morphia: others are codeine and narcotine, with meconic and sulphuric acid. Sanguinaria canadensis, Blood root or Puccoon, is well known for the red color of its juice.

Papaver somniferum, Poppy (*pl.* 66, *fig.* 9); *a*, a flowering branch; *b*, bud, a sepal removed; *c*, pistil; *d*, capsule, opened at the side; *e*, seed magnified; *f*, seed of natural size; *g*, stamen.

Chelidonium majus, Celandine (Europe) (*pl.* 66, *fig.* 10); *a*, *b*, flower and fruit branch; *c*, bud; *d*, flower; *e*, stamen; *f*, pistil; *g*, capsule.

Order 212. Sarraceniaceæ, the Sidesaddle-flower Family. Sepals five, persistent, imbricated in æstivation, often with coherent bracts outside. Petals five, hypogynous, concave; occasionally the corolla is absent, and the calyx consists of four to six segments. Stamens 00; anthers adnate, dithecal, introrse, with longitudinal dehiscence. Ovary free, tri-quinquelocular; style single; stigma persistent, either a truncated point, or large and peltate with five angles; ovules anatropal. Capsule three- to five-celled, with loculicidal dehiscence. Seeds very numerous, small, attached to large placentas which project from the axis into the cavity of the cells; albumen copious; embryo cylindrical, lying at the base of the seed; radicle pointing to the hilum. Herbaceous plants, found in boggy places, having radical leaves, the petioles of which are folded, and cohere so as to form ascidia or hollow tubes. Scapes one- or more-flowered. The plants are found in North America and Guiana. Their properties are not known. Lindley enumerates two genera, including seven species. Examples: Sarracenia, Heliamphora. All of these are North American, excepting Heliamphora with one species, found in Guiana at considerable elevations. Sarracenia purpurea is the Sidesaddle flower of the northern States.

Order 213. Nelumbiaceæ, the Water-Bean Family. Sepals four to five. Petals numerous, in many rows. Stamens indefinite, in several rows; filaments petaloid; anthers adnate, introrse, opening by a double longitudinal cleft. Torus large, fleshy, elevated, inclosing in hollows of its surface numerous carpels. Nuts numerous, inserted, but loose, into the depressions of the torus. Seeds one to two; perisperm none; embryo

inclosed in a vitellus, large with two fleshy cotyledons. Aquatic herbs, with showy flowers, peltate floating leaves, and prostrate rootstocks, found in the temperate and tropical regions of the Old and New Worlds. Lindley enumerates one genus, including three species. Example: Nelumbium. North America possesses one species, Nelumbium luteum, found in ponds and lakes of the southern and western States, more rarely in the middle and eastern. The floating leaves are sometimes one to two feet in diameter. The tubers, when boiled, furnish an agreeable food somewhat like the potatoe, and are gathered by some Indian tribes.

ORDER 214. NYMPHÆACEÆ, the Water Lily Family. Sepals usually four, sometimes compounded with the petals. Petals numerous, often passing gradually into stamens. Stamens indefinite, inserted above the petals into the torus; filaments petaloid; anthers adnate; introrse, opening by two longitudinal clefts. Torus large, fleshy, surrounding the ovary more or less. Ovary multilocular, many-seeded, with radiating stigmas; numerous anatropal ovules. Fruit many-celled, indehiscent. Seeds very numerous, attached to spongy dissepiments; albumen farinaceous; embryo small, inclosed in a fleshy vitellus, and situated at the base of the perisperm. Aquatic plants, with peltate or cordate fleshy leaves, and a rootstock or stem which extends itself into the mud at the bottom of the water. Lindley enumerates five genera, comprehending fifty species. Examples: *Nymphæa, *Nuphar, Victoria, Euryale. Nymphæa odorata is the white Water Lily found in various parts of the United States. Nuphar advena is the common Splatter-Dock. There are two other species in North America, one more northern, the other more southern. Schomburgh has recently discovered a new genus Victoria in Guiana, the flowers of which are a foot in diameter, the leaves from four to six and a half feet.

Nymphæa lotus (Egypt) (*pl.* 58, 59, *fig.* 9).

ORDER 215. CABOMBACEÆ, the Water Shield Family. Sepals three to four. Petals three to four, alternate with the sepals. Stamens hypogynous, arising from an inconspicuous torus, two or three times the number of the petals; anthers linear, introrse, continuous with the filament. Carpels two or more; stigma simple; ovules orthotropal. Fruit indehiscent, tipped with the indurated styles, containing one or two pendulous seeds. Embryo small, inclosed in a vitellus (the sac of the amnios), and placed at the base of a fleshy perisperm. American aquatic plants, with floating peltate leaves. Lindley mentions two genera, including three species. Examples: Cabomba, *Brasenia. Of the two known genera, Cabomba has two species in Guiana and one in the southern United States. Brasenia with one species (B. peltata) is found in North America, and possibly in New Holland.

ORDER 216. BERBERIDACEÆ, the Barberry Family. Sepals three, four, to six, deciduous, in a double row. Petals hypogynous, equal in number to the sepals, and opposite to them, or twice as many, often having an appendage at the base on the inside. Stamens equal in number to the petals, and opposite to them; anthers adnate, bilocular (dithecal), each of the loculi opening by a valve from the bottom to the top. Carpel solitary, unilocular, containing two to twelve anatropal ovules; style sometimes lateral; stigma

orbicular. Fruit baccate or capsular, indehiscent. Albumen fleshy or horny; embryo straight, sometimes large. Shrubs or herbaceous perennial plants, with alternate, compound, exstipulate leaves. The true leaves are often changed into spines. Found chiefly in the mountainous parts of the temperate regions of the northern hemisphere. *Tribe* 1. *Berberideæ.* Embryo in the axis, and occupying nearly the whole length of the albumen. Shrubs. Example: *Berberis. *Tribe* 2. *Nandineæ.* Embryo minute at the base of the albumen, often oblique with respect to the hilum. Perennial herbs. Examples: *Leontice, *Podophyllum.

Lindley enumerates twelve genera with one hundred species, of which seven genera with eleven species belong to North America. Berberis vulgaris and canadensis constitute the Barberry plant, known for the acidity of the fruit, which is caused by the presence of oxalic acid. Podophyllum peltatum is the May-apple.

Berberis vulgaris, Barberry (Europe) (*pl.* 68, *fig.* 5); *a*, flowering branch; *b*, a flower; *c*, calyx and pistil; *d*, stamens; *e*, berry; *f*, longitudinal section of a berry; *g*, the seed.

Order 217. Menispermaceæ, the Moon-Seed Family. Flowers usually unisexual (often diœcious). Sepals and petals similar in appearance, in one or several rows, three or four in each row, hypogynous, deciduous. Stamens monadelphous, or occasionally free; anthers adnate, extrorse. Carpels solitary or numerous, distinct or partially coherent, unilocular; ovule solitary, curved. Fruit a succulent, one-seeded, oblique or lunate drupe. Embryo curved or peripherical; radicle superior; albumen fleshy, sometimes wanting. The plants of this order are sarmentaceous or twining shrubs, with alternate leaves, and very small flowers. The wood is frequently arranged in wedges, and hence the order was at one time put under the division called Homogens by Lindley. The order is common in the tropical parts of Asia and America. There are twenty-three known genera, including 202 species. Examples: *Menispermum, Cissampelos, *Cocculus. Two genera with three species represent this order in North America. The Cocculus indicus of the shops is the fruit of Anamirta cocculus. Although highly poisonous, it is employed by some brewers to give bitterness to porter. It is also used to intoxicate and capture fish.

Order 218. Anonaceæ, the Custard-Apple Family. Sepals three or four, persistent, often partially cohering. Petals six, hypogynous, in two rows, coriaceous, with a valvate æstivation. Stamens indefinite (very rarely definite); anthers adnate, extrorse, with a large four-cornered connective. Carpels usually numerous, separate or cohering slightly, rarely definite; ovules anatropal, solitary or several, erect or ascending. Fruit succulent or dry, the carpels being one- or many-seeded, and either distinct or united into a fleshy mass; spermoderm brittle; embryo minute, at the base of a ruminated perisperm. Trees or shrubs, with alternate, simple, exstipulate leaves, found usually in tropical countries. Lindley enumerates 20 genera, including 300 species. Examples: Anona, Uvaria, Gualteria, *Asimina. There are four species of Asimina in the United States. One of these, A.

tribola, is the Papaw of the western and middle States. Anona cherimolia furnishes the Cherimoyer of Peru. The lancewood in so much request for carriages, fishing-rods, &c., is furnished by Duguetia quitarensis, a native of Guiana.

Anona squamosa, Anona, West Indies (*pl.* 68, *fig.* 3); *a*, flowering branch; *b*, receptacle; *c*, stamen; *d*, fruit in section; *e*, seed; *f*, ditto in section.

ORDER 219. MAGNOLIACEÆ, the Magnolia Family. Sepals two to six, usually deciduous. Petals two to thirty, hypogynous, often in several rows. Stamens indefinite, distinct, hypogynous: anthers adnate, dehiscing longitudinally. Carpels numerous, one-celled, arranged upon a more or less elevated receptacle; ovules anatropal, suspended, or ascending; styles short. Fruit consisting of numerous distinct or partially coherent carpels, which are either dehiscent or indehiscent, sometimes samaroid. Seeds, when ripe, often hang suspended from the carpels by a long, slender cord; embryo minute, at the base of a fleshy perisperm. Trees and shrubs, with alternate coriaceous leaves, and deciduous convolute stipules. They abound in North America, and some species occur in South America, China, Japan, New Holland, and New Zealand.

Sub-order 1. *Magnolieæ.* Carpels spicate on the elongated torus. Anthers long. Scales of the leaf-bud formed of convolute stipules. Examples: Talauma, *Magnolia, *Liriodendron, Michelia.

Sub-order 2. *Illicieæ.* Carpels in a single whorl, anthers short. Leaves with transparent dots. Examples: Tasmannia, Drimys, *Illicium.

Sub-order 3. *Schizandreæ.* Flowers monœcious, or diœcious. Pistils imbricated, spicate, or capitate. Stamens in a cluster, monadelphous, or distinct. Stipules none. Leaves entire or toothed. Stems often sarmentose. Mucilaginous, the seeds aromatic. Examples: Sphærostemma, *Schizandra.

The order, according to Lindley, contains eleven genera and sixty-five species, of which three genera and ten species are North American. The Magnolias belong principally to the United States and to China. Magnolia grandiflora has flowers six to eight inches in diameter. M. macrophylla has leaves from one to three feet in length. The cucumber tree of the middle States is M. acuminata. M. glauca is a small species found in wet places along the Atlantic coast, and possessing very fragrant white flowers. Winter's bark is obtained from Drimys winteri, or aromatica, brought from the Strait of Magellan, in 1579, by Captain Winter. Liriodendron tulipiferum is the American Tulip tree, or Poplar, which furnishes the valuable cabinet wood, known as poplar. (The wood of Populus, or the true Poplar, is unfit for manufacturing purposes.) Several species of Illicium or Anise are found in the United States.

Illicium anisatum, Star Anise, China and Japan (*pl.* 68, *fig.* 2); *a*, flowering branch; *b*, flower from above; *c*, pistil and stamens; *d*, stamens; *e*, pistil; *f*, seed vessels; *g*, seed.

Magnolia grandiflora, United States (*pl.* 68, *fig.* 1); *a*, leaves and

flower; *b*, a capsule burst, and a seed hanging out by the funiculus; *c*, *d*, seeds.

ORDER 220. DILLENIACEÆ, the Dillenia Family. Sepals five, persistent. Petals five, deciduous, in a single row. Stamens indefinite, hypogynous, either distinct or combined into bundles; filaments dilated at the base or apex; anthers adnate, introrse, with longitudinal dehiscence. Ovaries definite, more or less distinct, with a terminal style and simple stigma; ovules ascending. Fruit of two- to five-capsular, or baccate unilocular carpels, which are either distinct or coherent. Seeds irillate, several in each carpel, or only two, or one by abortion; testa (spermoderm) hard; embryo straight, minute, at the base of fleshy albumen. The plants of the order are trees, shrubs, or undershrubs, having alternate, exstipulate, coriaceous, or rough leaves. They are found chiefly in Australasia, Asia, and the warm parts of America. They have astringent properties, and some of the species afford excellent timber. Lindley enumerates 26 genera, including 200 species. *Tribe* 1. *Dilleniæ.* Anthers with linear cells. Australasian species. Example: Dillenia. *Tribe* 2. *Delimeæ.* Anthers with rounded cells. Species mostly American, some few Asiatic or African. Example: Delima.

ORDER 221. RANUNCULACEÆ, the Crowfoot Family. Sepals three to six, frequently five, deciduous. Petals five to fifteen, rarely abortive, sometimes anomalous in form, occasionally with scales at the base. Stamens usually indefinite, hypogynous; anthers adnate; carpels numerous, one-celled, distinct, or united into a single many-celled pistil; ovary containing one anatropal ovule, or several united to the inner edge. Fruit various, either dry achænia, or baccate, or follicular. Seeds albuminous, erect, or pendulous; albumen horny; embryo minute. Herbaceous, suffruticose, or rarely shrubby plants, having alternate, or opposite, simple, much-divided leaves, with dilated sheathing petioles. Juice watery. Hairs, if present, simple. *Tribe* 1. *Clematideæ.* Calyx colored, with valvate æstivation. Petals none or shorter than the sepals. Achænia one-seeded, with the styles much elongated and plumose, the seed pendent. Generally climbing shrubs with opposite leaves. Examples: *Clematis, *Atrogene. *Tribe* 2. *Anemoneæ.* Calyx often colored, with imbricate æstivation. Petals none or plane. Achænia one-seeded, with styles often much elongated and plumose, with pendent seeds. Herbs with leaves usually radical, the cauline alternate; flowers often involucred. Examples: *Thalyctrum, *Hepatica, *Hydrastis, *Anemone. *Tribe* 3. *Ranunculeæ.* Calyx with imbricated æstivation. Anthers extrorse. Petals with a small nectariferous scale or gland at the base inside. Seed erect, sometimes suspended. Herbs with the leaves radical or alternate; the flowers solitary, not involucred. Example: *Ranunculus. *Tribe* 4. *Helleboreæ.* Calyx with imbricated æstivation. Petals none or irregular, often tubular or bilabiate. Carpels follicular, many-seeded. Herbs with the leaves radical, or with the caulinary alternate. Examples: *Caltha, *Trollius, Helleborus, *Delphinium, *Aconitum, *Aquilegia. *Tribe* 5. *Pæonieæ.* Calyx with imbricate æstivation. Petals plane or none. Carpels fleshy or capsular, often one-seeded

by abortion. Herbs or undershrubs. Examples: *Actæa, *Cimifuga, Xanthorrhiza, *Pæonia.

The entire order embraces 41 genera with 1000 species, of which 20 genera and about 140 species are North American. Some species are more or less poisonous. Aconitum napellus, or Monkshood, contains aconite. A. ferox furnishes the well-known East Indian poison, called Bikh. The seeds of Delphinium, or Larkspur, are used in some sections of country for destroying vermin on the heads of children.

Pulsatilla pratensis, Europe (*pl.* 66, *fig.* 3); *a*, plant without the root; *b*, stamens; *c*, receptacle with the fruit; *d*, section of the fruit.

Anemone hortensis, Garden Anemone, Europe (*pl.* 66, *fig.* 2).

Clematis erecta, Europe (*pl.* 66, *fig.* 1); *a*, stamens; *b*, achænium; *c*, stamen; *d*, achænia together.

Adonis vernalis, Europe (*pl.* 66, *fig.* 5); *a*, flower branch; *b*, a pistil; *c*, receptacle; *d*, fruit.

Ranunculus acris, Europe (*pl.* 66, *fig.* 4); *a*, *b*, flowers, leaf, and fruit; *c*, fruit.

Helleborus niger, Black Hellebore, Europe (*pl.* 66, *fig.* 6); *a*, *b*, leaf and flower; *c*, receptacle with nectaries, pistils, and one stamen, the rest removed; *d*, seed vessel; *e–g*, seeds.

Aconitum stœrkianum, Europe (*pl.* 66, *fig.* 8); *a*, *b*, flower branch with leaves; *c*, vertical section of flowers; *d*, stamen; *e*, capsule; *f*, seed; *g*, root.

Aquilegia vulgaris, Columbine, Europe (*pl.* 66, *fig.* 7); *a*, root leaf; *b*, flower branch; *c*, cauline leaf; *d*, pistils and stamens, only three of the latter remaining; *e*, section of fruit; *f*, *g*, seeds.

[illegible]

ZOOLOGY.

PLATES 74–118.

General Introduction.

ZOOLOGY is a systematic exposition of animals according to their external and internal structure, and the functions of their organs. The internal structure can be frequently inferred from the external characters; we may, for example, determine the aliment of an animal, and the structure of the digestive organs, by examining the teeth. This is, however, not sufficient in all cases, so that it becomes necessary also to examine the internal parts, because the relation between animals depends upon the entire organization; and this being well ascertained, the functions of the various organs can generally be determined without much difficulty.

From the earliest period it was found necessary to group those animals together which were observed to have certain natural characters in common. We find, upon inquiry, that the endeavors to arrange animals systematically have taken two principal directions, which have been named *natural* and *artificial* classification. The former has in view the classification of animals upon the greater or less perfection of the various organs, among which those connected with the circulation and oxygenation of the blood, locomotion, and digestion, hold a prominent place; the latter depends upon a character or habit arbitrarily chosen, and independent of others. A character, however, which may be regarded as unessential by one observer, will be considered as of the greatest importance by another. In the earlier stages of science, when the number of known species was comparatively small, artificial methods were popular, because they were considered easy of acquisition: now, however, it is found that they are calculated to give superficial ideas; and that to present the condition of zoological science in its true light, a more philosophical system must be made use of.

Aristotle, whose great mind was master of many sciences, both moral and physical, and whose works had an authority in Europe for many centuries, second only to that of the sacred Scriptures, takes precedence, in point of time, as the first systematic zoological observer. Born at Stagira, in the year 383 before Christ, he became the instructor of Alexander the Great, who formed a large collection of animals to enable him to pursue his investigations. As a history of zoological systems forms no part of the plan of this work, only a short outline of the most important periods will be given.

ARISTOTLE divides animals into such as have blood, and such as are

without it. The former comprehends the (A) VERTEBRATA, and the latter the (B) EVERTEBRATA of later authors. These are subdivided as follows:

A.

Animals which are	VIVIPAROUS, - - - -	MAMMALIA.
" " "	OVIPAROUS,	
	with four feet, - - -	REPTILES.
	with two feet and wings, -	BIRDS.
	without feet, - - -	SERPENTS.
	with fins, - - - -	FISHES.

B.

Animals	without shells, - - - - -	WORMS.
"	with a soft shell, - - - - -	CRABS.
"	with a calcareous shell, - - -	SNAILS.
"	with an articulate body, - - -	INSECTS.

PLINY the elder, nearly four hundred years later, compiled an extensive work on natural history, but without offering a system, or adding any original matter of scientific value, although the large collections of living animals in Rome must have afforded him many facilities for study.

GALEN paid more attention to the internal structure than to the formation of a system; and from his time, A.D. 200, to the fifteenth century nothing was done of any account.

BELON, the reviver of natural history in modern times, was born in 1517, and after travelling three years in Europe, Egypt, Greece, and Asia Minor, at the expense of the bishop of Mans and Clermont, and the cardinals of Tournon and Lorraine, he returned to Paris in 1550 with a large collection, when he published his works.

RONDELETIUS, a medical professor at Montpellier, published a work in 1554, on Ichthyology; and another appeared in the same year, upon the same subject, by SALVIANI, a Roman physician.

CONRAD GESNER, a physician born at Zurich, in 1516, published an extensive history of animals in 1585.

ALDROVANDI, a professor of Bologna, born in 1525, was the author of fourteen folio volumes, published between 1599 and 1640.

MOUFFET'S *Theatrum insectorum*, the earliest English zoological work, was published in 1634. Most of the authors of this period repeated the fables of Pliny, or were deceived by those who sold factitious curiosities, a remnant of which still remains in the occasional appearance of a stuffed mermaid or impossible fossil. It was not until the appearance of Linnæus that natural science was placed upon a permanent basis. Born in Sweden, in 1707, he was at first intended for the Church, but subsequently studied

medicine, suffering much from destitution during the period of his studies. In 1732 the University of Upsal sent him upon his celebrated Lapland tour. After this he taught mineralogy, and in 1735 took his medical degree.

LINNÆUS, whose great mind embraced the three kingdoms of nature, established the artificial method; since he indicated and arranged animals, plants, and minerals, by means of a few characteristics, enabling every naturalist to find a special name for each animal—a method which should as much as possible serve as a complete catalogue, convenient for ascertaining the names of known species, or of intercalating such as might be unknown. His classification is briefly as follows:

1. Animals whose heart has two ventricles and two auricles; blood warm and red.
   Viviparous. MAMMALIA. Oviparous. AVES (Birds).
2. Animals whose heart has one ventricle and one auricle; blood cold and red.
   With lungs. AMPHIBIA (Reptiles). With gills. PISCES (Fishes).
2. Animals with one ventricle and no auricle; blood cold and yellowish.
   With antennæ. INSECTA (Insects). With tentacles. VERMES (Worms).

The Linnæan Vermes included Intestina, Mollusca (not those of later authors), Testacea, Zoophyta, and Infusoria.

The impulse which Linnæus gave to the study of nature resulted in large collections formed in exotic regions chiefly by his disciples, among whom were Thunberg, Forskol, Spaarman, Hasselquist, and Osbeck; and as these collections contained many species which could not be properly arranged according to his system, the want of a more natural one was soon felt, and this was finally supplied by the immortal Cuvier, who laid the foundation of a natural classification in a deep study of the entire structure of the animal frame; showing, for example, how the characters of an unknown fossil animal might be determined from a few bones.

CUVIER was born in 1769, at Montbéillard, on the Alaine, in France, then belonging to the house of Würtemberg; and died in 1832, aged sixty-three. The national museum at Paris, the first in Europe, was the chief scene of his triumphs. He divides animals into VERTEBRATA and INVERTEBRATA, separating the first into *Mammalia* or beasts; *Aves* or birds; *Reptilia* or reptiles; and *Pisces* or fishes. The Invertebrata he separates into *Mollusca* or shellfish; *Articulata* or insects, &c.; and *Radiata*, including starfish and some heterogeneous materials.

The most recent mode of determining the relative station of animals, is that employed by AGASSIZ, founded upon the development of the young from the ovum; a mode which, in the hands of this distinguished professor, has in some cases furnished more certain results than the consideration even of the nervous system.

Zoology is distinguished as general and special. The former compares the internal and external structure of animals, not only to understand the phenomena of animal growth and life, but also to unravel the laws

according to which the organs are developed from the lowest to the highest classes which associates it with comparative anatomy and physiology; the latter compares individual animals with each other to determine the peculiarities of individual species, treating of their character and habits.

The attempt has been frequently made to arrange animals in a regular scale from the lowest to the highest, under the impression that each animal must have an equal, a higher, or a lower organization when compared with others. This might be the case if there were only one set of organs; but as there are many, an animal may have a simple organization in one, and a complicated one in another. Thus by their organs of locomotion and general economy, insects would be placed above mollusca, whilst the latter are allied to the higher orders by their circulation. One proposes to arrange animals in a series of parallel lines, whilst another thinks that their affinities will be best shown by arranging them in a circle. The entire organism being moved through the nervous system, this has more recently received a great share of attention; and although it has proved satisfactory to a certain extent, it is at times difficult to make safe deductions from variations in the details. Under these circumstances, there are to be found those who, like Duméril and Swainson, think that external characters are sufficient for the classification of animals, as it is through these that they are placed in communication with external nature. Blainville makes the external organs the basis of his twenty-five divisions; considering their position, the skin and its appendages, and the structure and uses of the limbs.

There are many important affinities between plants and animals, as we have already mentioned in the introduction to Botany. One of the most important of these has been discovered in modern times, by means of the improved microscope. Thus it has been shown that the structure and growth, as well in animals as in plants, is due to cells. There are, besides, other points of similarity, which will be stated further on.

It is still doubtful whether certain organisms belong to plants or animals, there being grounds upon each side of the question. Some animal productions, as corals, were at an early day regarded as plants; whilst certain vegetable productions have, until a recent period, been considered animals, and indeed some are still considered such. These doubtful organisms are to be found chiefly among the low and minute forms which require a microscope for their investigation. In the case of sponges, strong arguments have been brought forward upon both sides, by acute observers who have examined them in a living state, for the sponge of commerce is a mere skeleton.

At first view, animals and plants would seem to be sufficiently separated by the respiration; as the former breathe and assimilate oxygen and expel carbonic acid gas, whilst in the latter this operation is reversed. This view of a contrary action is, however, not strictly correct, because in animals respiration must continue without intermission, whilst plants breathe inwards by day and outwards by night. Leaves and spiral vessels are the breathing organs of plants; gills, tracheæ, and lungs, those of animals. With regard to nutrition, animals and plants are nourished by extraneous

materials suitable to their organization, which are taken up and distributed by vessels, which do not correspond, however, except that those of plants may be considered similar to the alimentary canal of animals. In certain plants, as in Chelidonium and Vallisneria, a kind of circulation has been observed.

A still greater relation appears in the propagation of animals and plants, which frequently takes place in both kingdoms by means of spontaneous division, and the growth of the separating shoots or buds, as in the case of the creeping roots, and the shoots of many plants; and also in some animals, where numerous stems united by a common base, give rise to others which become separated and commence an independent existence, as in the polypi. The spontaneous division of the infusoria belongs to this mode of reproduction. Plant and animal eggs can also be brought into comparison with each other, if the lower orders of both be taken for this purpose. The phenomena of vegetable life which are also present in the animal kingdom, may be stated as follows:

1. The ability of individual portions when detached to grow and live independently, and even to originate others. Many plants can be increased by cuttings, and it is well known that pieces cut from fresh water polypi will grow and form perfect individuals.

2. As plants always produce new shoots, so in the corals are similar parts produced; and as a tree placed with its top in the ground may produce leaves and blossoms from the upturned roots, so the base of a sertularia may become the head by producing young polyps.

3. The formation of buds happens in both kingdoms, of which the polypi again afford examples.

4. In plants we also find traces of irritability, like the movements of the mustard plant when touched. Animals and plants are both subject to sleeping and waking.

5. Plants and animals undergo metamorphosis, and sustain malformation and disease, which sooner or later result in death, after which both are subject to fermentation and putrefaction.

6. Plants and animals, and their organs, are developed gradually according to a certain plan. As the root and stem are formed out of the seed, and the leaves from the cotyledons, until at length the flower and its component parts are produced, so we find the several organs of the animal body to be formed from the membrane of the yolk.

7. As there are plants which live but a few days, or even hours, like many fungi, so there are animals, as the ephemera. Most plants, like most insects, live but a single summer. On the other hand, plants as well as animals may attain a very great age, and examples are not rare of trees a thousand years old. Animals also become very old, although it is difficult to arrive at any certain conclusion upon this point. There is reason to believe that the crevish or river crab (Astacus) lives about twenty years; the honey bee ten years; the pike several centuries; carps and eels a century; crocodiles and tortoises, whose growth continues during a long period, probably attain a very great age; a toad was watched in a house for thirty-

six years; chickens live from twenty to thirty years; parrots, ravens, and swans, from eighty to one hundred; a goose lived to near one hundred; an ass thirty-six; and a horse sixty. The colossal mammalia may live several centuries.

8. Plants and animals are subject to hybernation, a phenomenon which we find especially in the polar and temperate zones, partly on account of the absence of the necessary heat, the deficiency of the means of subsistence, but also on account of a peculiar organization. In this condition plants lose their leaves and animals fall into a continued death-like sleep, concealed in holes and caves. All the functions are limited to their minimum. In hot regions we find a corresponding summer repose in animals and plants, connected with the great heat and aridity of the season. Then many tropical plants shed their leaves; crocodiles lie in the mud apparently dead, land shells close their aperture by a diaphragm; and certain freshwater species bury themselves at the bottom of ponds which become desiccated, until the return of the rainy season calls them to renewed life.

9. Plants, like animals, exhibit, under certain circumstances, great tenacity of life. Seeds of plants can preserve their germinating power for a long time, that of beans lasting one hundred years or more. An onion found in the hand of an Egyptian mummy germinated after an interval of not less than two thousand years, and the same thing happened with some cereal grains. The eggs of infusoria seem to afford a parallel in the animal kingdom. The examples cited of living toads found embedded in solid stone have not been sufficiently well authenticated to be admitted as facts, nor have the species thus said to be found ever been described or named.

10. Plants and animals become degenerate, as in the case of cultivated vegetables, which are sometimes quite unlike their original species.

11. There are living plants and animals which are capable of giving light in the dark, as some of the former which grow in subterranean passages, certain roots, and the blossoms of certain orange-flowered plants. Many animals, as the Medusas and fire-flies, emit a phosphorescent light; and it is well known that decaying animal and vegetable matter is luminous under certain circumstances.

But notwithstanding the various relations between plants and animals, there are still essential differences which it is sufficient merely to allude to here: The most essential distinction lies in the free will of the animal, and the power to make use of it in voluntary motion; and the presence of nervous matter to convey sensation. A mouth, muscles, bones, and organs of sense, are not present in any plant. Animal heat, electricity, and art, have no parallel among vegetables.

Instinct is peculiar to animals, like that of migration, defence, the constructions of bees and wasps, the expeditions of war and to make slaves which ants undertake, &c. Instinctive actions are not taught, although a permanent habit may become an instinct. The young duck swims at once, the young snapping turtle bites when taken from the egg, and a harmless serpent without fang or rattle will vibrate its tail like a rattlesnake, producing a similar sound among dry leaves. The brain of the young is

modelled upon that of the adult, and where the scale of ideas is limited, they must be as essentially hereditary as the external form.* An English writer endeavors to found a distinction between instinct and reason, by citing the case of a young animal, as a monkey, being terrified by one of its natural enemies, as a large serpent, when seen for the first time, which would not be the case with a young human being. Nevertheless, if man were for ages subject to be devoured by a large reptile, watching and caution would at length become habitual, and be transmitted as an instinct. The brain of the young is not necessarily that of the adult, but that of the adult at an earlier stage. So a quality or habit is not always transmissible from a parent to its immediate offspring, but it may appear in a more distant descendant, by a kind of "alternation of generations." Colonel Hamilton Smith considers the spotted horse as an original Asiatic race with which the ordinary breeds were sometimes crossed, and he thus accounts for the occasional appearance of examples of it. The original race is mild and intelligent, which is one reason for its frequent use in equestrian exhibitions.

One of the most important inquiries in the history of animals and plants, is that which relates to their distribution. That of the latter has been treated of under Botany; and as regards animals, our contracted space limits us to the following general view.

There are both aquatic and terrestrial animals, the number of which may perhaps be equal; but there are also species which can live both in water and on land, as many of the amphibia, and some other vertebrata. Some aquatic animals live partly in fresh, and some in salt water; but there are others which leave the sea to spawn in the fresh water, as the salmon. In the sea itself there are several regions depending upon the depth. Some marine animals live near or at the surface, others upon the bottom, in some cases within certain limits as to depth. Many land and sea animals live only as parasites upon or within others. Some species have a peculiar parasite, while others support several kinds.

Zoogeography, or the geographical distribution of animals, teaches the circumstances and positions under which animals occur, both as regards individual species, genera, or larger groups. The chief circumstances which seem to control animal distribution, are temperature, elevation, and natural barriers; whence it results that not only the continents, but much smaller regions, have their peculiar fauna. In proceeding from the tropics, species will be found to diminish rapidly. Some animals are circumscribed within very narrow limits, being confined to a single locality, as the curious reptile genus Amblyrhynchus to the Galapagos islands, or the Aurochs (Bison priscus) to a single forest in Russia. The genus Bradypus (sloth) and Dasypus (armadillo), Auchenia (llama), are confined to South America; the Marsupialia (possum, &c.) to America and Australia, and the Zebras to Africa. Others are more widely spread, as the dogs, bats, mice, &c.

* These views are favorable to the doctrine of innate ideas, which is generally opposed by speculative reasoners.

Libellula (*pl.* 74, *fig.* 44) *ferruginea* occurs from Spain to Java. Peltis pusilla, a coleopterous insect, inhabits China, Madagascar, and Brazil.

The brightest colored and the larger forms of animal life are generally found in the warmer zones, as the large crocodiles and gigantic serpents among reptiles, and the lions and tigers among cats. There are, however, some exceptions, as some of the largest whales inhabit cold climates, whilst the American mastodon was larger than any recent elephant.

Man exercises considerable influence upon the distribution of animals. Cultivation, and the removal of forests, together with hunting and fishing upon a large scale, drive them to other localities, and reduce their numbers; whilst steam navigation causes certain species of fish to leave rivers in other respects well adapted to them. For his own use, man transports various domestic animals, some of which, like the horse and ox in South America, have formed large wild herds. Goats and dogs occur similarly in certain islands. Some animals have been so long domesticated, that the original stock is unknown, if it still exists, as in the case of the cat and camel.

The animal kingdom is usually separated into two large sections by the presence or absence of an internal skeleton; a separation, however, which is not natural, as the two sections are not of equal value, as will appear when we speak of the divisions. The essential part of such a skeleton is the spine, composed of a series of vertebræ, whence the animals provided with it are named Vertebrata; and those without it Evertebrata or Invertebrate animals. The latter section is much the richest in genera and species; it is separated into three great divisions (the Vertebrata forming another) and many minor groups; and, from the difficulty which they present, there still remains a good deal of uncertainty in the classification of certain portions. The following sketch, together with *pl.* 74, represents the orders according to the classification of Cuvier somewhat modified, and generally in inverse order.

Instead of an internal skeleton, many of the evertebrate animals are provided with a kind of external skeleton for the protection of the inner soft parts. The chief distinction between them and the Vertebrata lies in the nervous system, which is not developed as a brain and spinal marrow, but as a nervous ring round the œsophagus, or as a double chord, with bead-like swellings at various intervals, as if the brain were divided into different centres of vitality, giving rise to various nerves. Hence, in dividing an insect into several parts, each seems to have nearly the same amount of vitality. Cuvier divides this section into THREE DIVISIONS, which are named RADIATA, MOLLUSCA, and ARTICULATA.

The Radiata are named from the arrangement of the parts around an axis somewhat as in plants, whence they are also called Zoophyta. The Mollusca or soft animals, which include the shellfish, are characterized by the soft pulpy and slimy nature of the body, which is inclosed in a kind of mantle; they are generally without regular limbs, and some are without a head. Their power of locomotion is generally limited, and some are altogether sedentary. The Articulata are distinguished by a ringed or

jointed body and limbs, the external part being the hardest, and partaking of the nature of an external skeleton. They are generally provided with well developed limbs, and are able to fly, run, and swim, with great facility. A few are without limbs. This division includes insects; Crustacea, or crabs; Arachnida, or spiders; and Annelida, or ringed worms.

Division I. Radiata.

Class 1. *Infusoria.*

This class includes animals so minute that many of them cannot be seen with the naked eye. They are named from being found in infusions of organic matter. They are generally provided with *vibrillæ*, or vibratile organs, also named *cilia*, which resemble a minute fringe of hairs, which are constantly in motion, causing either locomotion of the animalcula, or currents of water, which bring their food within their reach.

Order 1. Polygastrica (*Homogenea*, Cuvier), to which has been attributed a compound stomach, resembling a bunch of grapes, whence the name applied by Ehrenberg, who made the supposed discovery. The genus *Monas* (*pl.* 74, *fig.* 1) is an organized globule which moves by rotation. Some authors think they are not animals, but the seeds of Algæ. The smaller kinds are only from one to two thousandths of a line in length, so that a drop of water may contain half as many individuals as there are human beings upon the earth, or five hundred millions of them.

Order 2. Rotifera, in which the action of the vibrillæ is supposed to resemble a wheel in motion. They are now removed to the lowest position among the Crustacea. *Pl.* 74, *fig.* 2, *Monocerca.*

Class 2. *Zoophyta.*

This includes the abundant order of the coral animals, the naked Polypi (*fig.* 4), of which the freshwater species are the best known. The sponges (*pl.* 74, *fig.* 3) have also been placed here. The classification given here (that of *pl.* 74) is not followed in the subsequent pages.

Order 1. Corallina. *Pl.* 75, *figs.* 58, &c.
" 2. Gelatinosa. *Pl.* 74, *fig.* 4, *Hydra.*
" 3. Actinia. *Pl.* 77, *figs.* 5, 6.

Class 3. *Acalephæ.*

This class includes the Medusæ, Sea Jellies, Sea Nettles, &c. *Pl.* 76, *fig.* 74, *Aurelia.*

ORDER 1. HYDROSTATICA. *Pl.* 74, *fig.* 5, *Diphies.*
" 2. ACALEPHIA. Medusa. *Pl.* 74, *fig.* 6, *Velella.*

Class 4. *Echinodermata.*

Radiated animals with a hard integument, like those on *pl.* 76, *figs.* 60 to 71. Some have and some are without locomotive organs.

ORDER 1. EPEDICELLATA. *Pl.* 74, *fig.* 7, *Sipunculus.*
" 2. PEDICELLATA. *Pl.* 74, *fig.* 8, *Holothuria*, *Asterias*, *Echinus*, &c.

Class 5. *Intestina.*

In this class (excluding the Annelida) Cuvier placed the intestinal worms, and others which bear some resemblance to them, but which are not confined to the internal parts of animals.

ORDER 1. ENTOZOA (*Cavitaria*, Cuvier). *Pl.* 74, *fig.* 9, *Ligula.*
" 2. STERELMINTHA (*Parenchymata*, Cuvier). *Fig.* 10, *Nemertes.*

DIVISION II. MOLLUSCA.

Class 1. *Acephala.*

This class has no proper head, the mouth opening immediately into the anterior part of the body. The gills are suspended upon each side of the body. The Tunicata are without an external shell; the Conchifera have a bivalve shell.

ORDER 1. TUNICATA. *Pl.* 74, *fig.* 11, *Botryllus.* *Pl.* 77, *fig.* 3, *Salpa.*
" 2. CONCHIFERA. *Pl.* 74, *fig.* 12, *Ostrea.* See also *pl.* 76, *figs.* 25–50.

Class 2. *Gastropoda.*

In this class locomotion is effected by means of a fleshy disk, called a foot, upon the lower surface of the body. The orders are distributed according to the structure of the branchiæ. This class is abundant in species, and includes the greater part of the univalve shells.

ORDER 1. CYCLOBRANCHIATA. *Pl.* 74, *fig.* 13, *Chiton.*
" 2. SCUTIBRANCHIATA. " " 14, *Fissurella.*
" 3. TUBULIBRANCHIATA. " " 15, *Vermetus.*
" 4. CTENOBRANCHIATA. " " 16, *Strombus.*
" 5. HETEROPODA. " " 17, *Carinaria.*
" 6. TECTIBRANCHIATA. " " 18, *Bulla.*
" 7. INFEROBRANCHIATA. " " 19, *Phyllidium.*
" 8. NUDIBRANCHIATA. " " 20, *Tritonium.*
" 9. PULMONATA. " " 21, *Limnea.*

Class 3. *Pteropoda.*

In this class the organs of locomotion are a pair of fleshy, wing-like fins at the sides of the neck. It includes but one order. *Pl.* 74, *fig.* 22, *Clio.*

Class 4. *Cephalopoda.*

The body is formed like a sack, the head is surrounded with long arms, used for prehension and locomotion; the eyes are large, and the mouth armed with a strong beak. There is but one order in the class. *Pl.* 74, *fig.* 23, *Octopus.* *Pl.* 76, *figs.* 16, 17, 75, 76, 77.

Division III. Articulata.

Class 1. *Annelida.*

Worms with cold red blood, the body lengthened and divided into rings, of which the first forms the head. Articulated feet are never present, but many of the genera are provided with stiff movable bristles. Nearly all live in water; the *Lumbricus* (earth-worm) is, however, an exception. Some live in tubes which they form in the bottom, some form them out of agglutinated particles of sand, and others secrete a kind of shell. Some of these, on account of the shell, have been thoughtlessly classified with the Mollusca.

Order 1. Abranchiata.	*Pl.* 74,	*fig.*	24,	*Hirudo* (leech).
" 2. Dorsibranchiata.	"	"	25,	*Aphrodite.*
" 3. Tubicola.	"	"	26,	*Amphitrite.*

Class 2. *Cirrhopoda.*

This class was formerly included in the Mollusca, on account of the shell; its affinities are, however, with the Crustacea. They are attached to stones, corals, crabs, shells, the bottoms of ships, whales, and marine tortoises. *Pl.* 74, *fig.* 27, and *pl.* 76, *fig.* 52, *Anatifa.* *Pl.* 76, *fig.* 54, *Balanus.*

Class 3. *Crustacea.*

This class includes the articulata with articulate feet, which breathe by means of gills. Their circulation is double. There are two pair of antennæ, and never less than five pair of feet, and there are frequently

more. The integument is more or less hard, the eyes are either sessile or elevated upon movable pedicles, as in the two highest orders. The situation and form of the gills, the position of the head and tail, the structure and number of the feet and parts of the mouth, afford characters for their classification.

ORDER 1. TRILOBITA.		
" 2. PŒCILOPODA.	*Pl.* 74, *fig.* 34, *Caligus* (parasitic).
" 3. BRANCHIOPODA.	" " 33, *Cyclops* (waterflea).
" 4. ISOPODA.	" " 32, *Oniscus*.
" 5. LÆMODIPODA.	" " 31, *Cyamus* (whalelouse).
" 6. AMPHIPODA.	" " 30, *Talitrus*.
" 7. STOMATOPODA.	" " 29, *Squilla*.
" 8. DECAPODA.	" " 28, *Cancer*.

Class 4. *Arachnida.*

This class is provided with articulate limbs, and includes spiders, mites, and scorpions. They differ from insects in wanting antennæ, in having simple eyes, and in having the head coalescing with the thorax, and forming the cephalothorax. The feet are generally eight in number, being but six in insects; they are not subject to a metamorphosis, but moult the skin instead. The Pulmonaria (spiders and scorpions) breathe by a kind of lungs, or pulmonobranchiæ; the Trachearia (including the mites and some small aquatic species) by tracheæ, as in insects. Most of the Arachnida are predaceous in their habits.

ORDER 1. PULMONARIA.	*Pl.* 74, *fig.* 35, *Aranea*.
" 2. TRACHEARIA.	" " 36, *Chelifer*.

Class 5. *Insecta.*

Insects have articulated feet, a dorsal vessel instead of a heart, and they breathe through lateral spiracles, connected with two principal tracheæ. Some insects are apterous and some winged, the number of wings being either two or four. The four wings are of a similar texture in some, and of a different texture in others. In the Coleoptera the posterior pair alone are used in flight, the anterior pair being converted into covers for their protection whilst at rest. The number of feet is six, except in the vermiform centipedes and millipedes (Myriapoda), which have characters intermediate to the true insects and the annelida; and, indeed, they are regarded by some as a distinct class. Insects undergo a more or less complete metamorphosis, which, in the Myriapoda, is confined to an increase of the number of segments and feet. Insects do not grow in this perfect state, having attained their full volume previous to their final transformation.

ORDER 1.	MYRIAPODA.	*Pl.* 74, *fig.* 37,	*Scolopendra.*
" 2.	THYSANURA.	" " 38,	*Lepisma.*
" 3.	PARASITA.	" " 39,	*Pediculus.*
" 4.	SUCTORIA.	" " 40,	*Pulex.*
" 5.	COLEOPTERA.	" " 41,	*Carabus.*
" 6.	ORTHOPTERA.	" " 42,	*Forficula.*
" 7.	HEMIPTERA.	" " 43,	*Cimex.*
" 8.	NEUROPTERA.	" " 44,	*Libellula.*
" 9.	HYMENOPTERA.	" " 45,	*Tenthredo.*
" 10.	LEPIDOPTERA.	" " 46,	*Vanessa.*
" 11.	DIPTERA.	" " 47,	*Stomoxys.*

DIVISION IV. VERTEBRATA.

THE VERTEBRATE DIVISION of the animal kingdom, as has been already remarked, includes animals with an internal articulated skeleton or framework, capable of growth, supplied with blood-vessels and nerves, and serving for the support of the soft parts; and it is here that animals of the greatest size are found. The body is divided into head, trunk, and organs of locomotion, and the nervous system has attained its greatest concentration in a single brain or nervous centre. The group of Vertebrata having the same value as the previous DIVISIONS, it is unnatural to consider it as balancing the Evertebrata conjointly, and on this account it will be here considered as a division including the following classes.

Class 1. *Pisces.*

In all fishes the blood is oxygenated by means of gills, which are supported by a bony framework, named the branchial arches, which generally amount to four. The external structure is adapted for inhabiting and moving through the water. The air-bladder, although not concerned in breathing, is really the *homologue* of the lungs in the higher classes. It is not present in all fishes.

Fishes are divided into two series, according as the skeleton is *cartilaginous* or *osseous.* In the former the organization is low, the ribs are rudimentary, and in the lowest form the spine is a continuous line of cartilage not yet divided into vertebræ. The orders of cartilaginous or chondropterygeous fishes are as follows:

ORDER 1.	CYCLOSTOMATA.	*Pl.* 74, *fig.* 48,	*Petromyzon*, lampereel.
" 2.	SELACHII.	" " 49,	*Squalus*, shark.
" 3.	STURIONES.	" " 51,	*Acipenser*, sturgeon.

The osseous fishes, which are much the most numerous, are distributed in the following orders:

ORDER 1. PLECTOGNATHI. *Pl.* 74, *fig.* 52, *Orthagoriscus.*
" 2. LOPHOBRANCHII. " " 53, *Hippocampus.*
" 3. APODES. " " 54, *Anguilla*, eel.
" 4. SUBBRACHIATA. " " 55, *Pleuronectes;* 56, *Merlangus.*
" 5. ABDOMINALES. " " 57, *Cyprinus*, chub.
" 6. ACANTHOPTERYGII. " " 58, *Xiphias*, swordfish.

Class 2. *Reptilia.*

Reptiles are cold-blooded vertebrata, which breathe by means of lungs, or lungs and gills. The heart is composed of a large ventricle with which the two auricles communicate. The ventricle receives venous blood from the system through the right auricle, and oxygenated blood from the lungs through the left one, so that both pure and impure blood are mixed in the ventricle, previous to being sent through the system, a portion passing through the lungs. This peculiarity of the circulation accounts for these animals being cold-blooded, since in the animals with warm blood, one of the two ventricles transmits unmixed oxygenated blood to the system.

The brain of reptiles is small, and exercises less influence upon the system than in the higher classes, since they can live a considerable time when it is removed. The body is naked or covered with scales, but these are unlike those of fishes. The first order is named *Batrachia* by Cuvier, and *Amphibia* by other authors, on account of their adaptation to breathing both air and water at the same time, or at different periods of their life. In some of the amphibia the gills are permanent (*Gnesiobranchiata*), and in others they disappear (*Agnesiobranchiata*).

ORDER 1. BATRACHIA. *Pl.* 74, *figs.* 59, *Salamandra;* 60, *Rana.*
" 2. OPHIDIA. " " 61, *Vipera;* 62, *Boa.*
" 3. SAURIA. " " 63, *Anguis;* 64, *Ophisaurus;* 65, *Chirotes;* 66, 67, *Chalcides;* 68, *Bipes;* 69, *Anolis;* 70, *Scincus;* 71, *Tilicua;* 72, *Chamæleo;* 73, *Ptyodactylus;* 74, *Basiliscus;* 75, *Iguana;* 76, *Draco;* 77, *Agama;* 78, *Stellio;* 79, *Lacerta;* 80, *Tejus;* 81, *Crocodilus;* 82, *Plesiosaurus;* 83, *Ichthyosaurus.*
ORDER 4. CHELONIDEA. *Pl.* 74, *figs.* 84, *Chelonia;* 85, *Testudo.*

Class 3. *Aves.*

Birds are oviparous vertebrata, with warm blood and a double circulation, clothed with feathers, and provided with two feet and two wings. The air has access to various parts of the body, which diminishes their specific gravity, and assists them in flight. Of all the classes of animals this is the most strictly defined; and its characters are more uniform, and have fewer exceptions, on which account the classification presents some

difficulties. The chief characters used for this purpose are furnished by the bill and feet.

ORDER 1. PALMIPEDES. *Pl.* 74, *figs.* 86, *Anas;* 87, *Sula;* 88, *Pelecanus;* 89, *Procellaria;* 90, *Podiceps.*

ORDER 2. GRALLÆ. *Pl.* 74, *figs.* 91, *Phœnicopterus;* 92, *Rallus;* 93, *Scolopax;* 94, *Ardea;* 95, *Grus;* 96, *Otis;* 97, *Struthio.*

ORDER 3. GALLINACEÆ. *Pl.* 74, *figs.* 98, *Gallus;* 99, *Crax;* 100, *Columba.*

ORDER 4. SCANSORES. *Pl.* 47, *figs.* 101, *Psittacus;* 102, *Picus.*

" 5. PASSERES. " " 103, *Buceros;* 104, *Merops;* 105, *Sitta;* 106, *Alauda;* 107, *Cypselus;* 108, *Pica.*

ORDER 6. ACCIPITRES. *Pl.* 74, *figs.* 109, *Otus;* 110, *Vultur;* 111, *Milvus.*

Class 4. *Mammalia.*

The young are produced alive in this class, which differs from all others in nourishing the young with milk secreted by the mammary glands. The thorax and abdomen are separated by a diaphragm composed of muscles, which is used in respiration. Man, by his physical characters, stands at the head of this class; although from his moral attributes some naturalists have denied him a place in the animal kingdom.

ORDER 1. CETACEA. *Pl.* 74, *fig.* 112, *Balæna.*

" 2. RUMINANTIA. *a*, Cervidæ; *fig.* 113, *Cervus.*
b, Bovidæ; *fig.* 114, *Bos.*
c, Camelidæ; *fig.* 115, *Camelus.*

" 3. PACHYDERMATA. *a*, Solipeda; *fig.* 116, *Equus.*
b, Suidæ; *fig.* 117, *Sus.*
c, Proboscidea; *fig.* 118, *Elephas.*

" 4. MONOTREMATA. *Fig.* 119, *Ornithorhynchus.*

" 5. EDENTATA. *Fig.* 120, *Manis.* *Fig.* 121, *Bradypus.*

" 6. RODENTIA. *Fig.* 122, *Lepus.* *Fig.* 123, *Sciurus.* *Fig.* 124, *Castor.* *Fig.* 125, *Mus.*

" 7. CARNIVORA. *Fig.* 126, *Didelphis* (possum). *Fig.* 127, *Phoca* (seal). *Fig.* 128, *Mustela* (weasel). *Fig.* 129, *Viverra* (ferret). *Fig.* 130, *Felis* (cat). *Fig.* 131, *Hyæna.* *Fig.* 132, *Canis* (dog). *Fig.* 133, *Ursus* (bear).

" 8. INSECTIVORA. *Fig.* 134, *Erinaceus.*

" 9. CHIROPTERA. *Fig.* 135, *Vespertilio* (bat). *Fig.* 136, *Pteropus.*

" 10. QUADRUMANA. *Fig.* 137, *Lemur.* *Fig.* 138, *Hapale.* *Fig.* 139, *Simia.*

" 11. BIMANA. *Fig.* 140, *Homo.*

The order and classification which we propose to adopt, will be found to differ somewhat from the system given above, which is essentially that of Cuvier.

DESCRIPTIVE ZOOLOGY.

Class Porifera.

If sponges belong to the animal kingdom, they stand at the lowest point, where they will constitute a class to which Grant's name Porifera may be applied. In the living sponges the water is imbibed through the smaller pores, and flows out of the larger ones in a regular stream. They exhibit no sensation when pierced, torn, burnt, or acted upon by acids, so that they are exceeded in sensitiveness by many plants.

Dujardin considers that he has proved them to be groups of animals. In placing a fragment of living sponge under the microscope, it was found to shape itself into rounded masses, the edges of which changed their form continually; and small bits moved by contracting and expanding.

Johnston, in his History of British Zoophytes, classes sponges with plants, on the ground that they are permanently fixed, not irritable, their movements involuntary, a stomach wanting, and from their resembling the cryptogamia in taking their form from the object to which they are attached.

Mr. Hogg states that sponges have no tentacles, vibrillæ, mouth, œsophagus, stomach, gizzard, alimentary canal, intestine, anus, ovaria, ova, muscles, nerves, ganglia, irritability, palpitation, or sensation. "Surely, then, we cannot any longer esteem these natural substances to be individual animals, or even groups of animals, in which not one organ or a single function or property peculiar to an animal can be detected."

Sponges are usually marine, although there are a few species which are found in streams and stagnant water. They have a loose texture, covered and penetrated by a jelly-like substance; and they are perforated with numerous passages. The gelatinous substance seems alone to be present in the young, the fibrous substance appearing at a later period.

The species of spongia are numerous, about 150 kinds being described by Lamarck. The best known is *Spongia officinalis* (*pl.* 75, *fig.* 45). It is found attached to rocks and stones in the Mediterranean, particularly about the Greek islands, where they are collected by divers. Its reproduction is so rapid, that it may be collected in the same place after an interval of two years. The younger specimens are the most sought after, on account of their greater delicacy. Formerly burnt sponge was used in domestic medical practice for goitre, its action depending upon the presence of iodine.

The form of sponges is subject to an endless variety, and even the same species varies to a great degree, apparently with the locality; so that it is

difficult to classify them properly. They are principally made up of irregular, globular, fan-shaped, palmate, branched, cup-shaped, funnel-shaped (often of great size), tubular, leaf-shaped, or ragged forms, which either surround other objects, or rise upon a short pedicle. The cup-shaped *S. usitatissima*, and the trumpet-shaped *S. tubæformis*, are from the American seas. The former is an article of commerce. *S. fistularis* (*pl.* 75, *fig.* 44) is a large brown species, with fine and very flexible fibres, from the American seas.

Notwithstanding the investigations of zealous inquirers, polyps have not been found in sponges. A number of observers who have watched their growth from the commencement, first observed the gelatinous substance, and afterwards the filamentous matter in it, which may be regarded as a skeleton. The growth of sponges is quite different from that of corals, as might be expected from the absence of polyps. Some regard the circulation of water through sponges as a kind of breathing process, a view which is inadmissible. With respect to their propagation, but little is satisfactorily known. According to Olivi, small oval bodies are found in the jelly-like mass, especially in autumn, which have been too hastily named eggs.

Sponges contain calcareous or silicious spicula, in which they resemble certain plants. They may be detected by burning a piece of sponge and placing some of the ashes beneath a microscope. These spicula are uniform in each species; so that they are useful in affording specific characters.

The chief peculiarities of marine sponges are also found in the fresh water species, as *Spongillæ lacustris; S. fluviatilis;* and *S. friabilis*, which inhabit swamps and running streams. The three named species, however, constitute probably but one, at different stages of growth.

The following genera are placed here, because, according to Milne Edwards, they have no polyps (new edition of Lamarck, vol. 2, p. 208, 520, 522). Some of the best authorities place them among plants.

Penecillus penecillus, Linn. (*pl.* 75, *fig.* 37), resembles a hair pencil, and the stem has a whitish calcareous crust (American seas). *Flabellaria opuntia*, Linn. (*fig.* 36) (American seas). *Acetabulum mediterraneum* (*fig.* 41). *Corallina officinalis*, Linn. (*pl.* 75, *fig.* 38), white, reddish, or green, four inches long. *C. rubens* (*fig.* 35) (Mediterranean). These delicate bodies were long supposed to partake of the animal nature of the true corals; but the structure is now considered to be nearer that of the algæ.

Pedicellaria, Müller (*pl.* 75, *fig.* 4), is a portion of an *Echinus*.

Class Infusoria.

These minute animals have been observed and studied only since the discovery and improvement of the microscope. Several species were known in ancient times, because they occurred in such numbers as to discolor the water green or red, in the latter case giving it the appearance

of blood; but no one anticipated this discoloration (which was regarded as a mark of divine displeasure) to be due to animals.

Leeuwenhoek, in 1675, first observed the infusoria, in standing rain water, without being fully convinced of their animal nature. Subsequently, in pursuing some medical inquiries into the nature of the material which gives its pungency to pepper, he made an infusion of this substance, which he was afterwards astonished to find swarming with animals. They were subsequently found in infusions of other vegetables, and in those of animal and metallic substances; and although it has been found that infusions are not essential to their production, they still retain the name of Infusoria. They are also called Protozoa, because they were supposed to constitute the first appearance of animal life. In the year 1701, Leeuwenhoek discovered that Rotifera, from the sediment which had been dried for a year in the gutter of a roof, could be revived. From this date, notwithstanding the number of observers, no one seemed disposed to investigate the internal structure of these minute objects, until the researches of Ehrenberg showed that they are provided with at least a mouth and a digestive cavity.

The larger species of Infusoria attain the size of a tenth of a line or more. The body is gelatinous and naked, but some are protected by a coriaceous, calcareous, or silicious defence; and as these mineral materials remain after the death of the animal, they are sometimes so abundant as to form entire geological formations. Some Infusoria have the body covered with minute sandy particles; others have only a shield upon the back; others again have the entire body inclosed in a case with one or more openings. When a defence is present, it is usually in a single piece, although there are some composed of more.

The Infusoria are usually colorless and translucent, but some are green, some yellow, and a few red; and when these colored species are very abundant, they give the water a discolored appearance. The shape is globular, oval, fusiform, cylindrical, vermiform, or irregular; and some are continually varying their form, so that the same individual might be mistaken for several distinct species. This is especially the case in the genus *Proteus*, which has derived its name from the sudden and great variation of form the same individual assumes under the eye of the observer. A head, neck, and tail, are usually distinguishable, and in some one end is very long, giving the animal a fanciful resemblance to a swan. The tail is sometimes used as a foot, and in some species is capable of being extended like the tube of a telescope. There are various external appendages like spines or bristles, but the most usual of these are the *vibrillæ*, which are used in locomotion, and to draw the food within reach by forming a kind of minute whirlpool in the water. In the Rotifera (which are really Crustacea) the vibrillæ are arranged in two circles at the anterior extremity; and when they are in action, some observers fancy that they resemble wheels in a state of rotation, whence the name of rotifera.

The *Baccilariæ* (now regarded as plants) are united together side by side in ribbon-like bands. *B. paradoxa* is a very interesting species, which may be compared to a ruler; but as many individuals rest side by side like

rulers upon a table, they may form a square or parallelogram. The motion is peculiar, each single body (the edges remaining in a line) being capable of sliding rapidly along the one with which it is in contact; so that when those upon one side have extended themselves, the whole may resemble a flag attached to a pole, as in the diagram.

The *Gaillonellæ* (plants) are united end to end, forming a chain. In the genus *Meridion* the individual parts or frustules are wedge-shaped, so that when placed edge to edge they form an arch, or even a circle or spiral. In *Micrasterias* the interior is divided into many cells. *Isthmia* has an end fixed, and forms rows, the parts being in contact at different angles by a small isthmus.

All the animal Infusoria seem to be provided with a mouth, which is generally terminal, but sometimes placed near the middle of the body. The vent is not always present, or at least has not been discovered in all, so that it is possible that the undigested portion of the food may be rejected from the mouth, as in the Polypi. Where it has been observed, the vent was near the mouth; or upon the abdomen; or at the posterior extremity, above or below. The breathing organs, where they have been observed, appear as simple openings. The organs of motion are the tail, foot, bristles, vibrillæ, &c.

The organs of sense, as far as known, are those of feeling (of which the snout, and perhaps the bristles, are the organs), and perhaps vision, although Dujardin doubts the existence of the latter. The organs supposed to be eyes are dark red or black stigmas situated anteriorly upon the upper side, and Ehrenberg thinks that a glandular body beneath them performs the function of an optic nerve. Most of the polygastrica have a single stigma, *Distigma* has two; some of the Rotifera (crustacea) two, three, four, or more, arranged in two clusters, as in *Theorus;* in a semicircle, as in *Cyclogena;* or upon pedicles (like those of land snails) as in *Otoglena.* It is uncertain whether the structure of these eye-like spots resembles that of any of the animals above them; or whether their vision, if they possess this sense, is more than sufficient to distinguish light from darkness. Indeed, a perfect vision would scarcely be of much use to them, as they are said not to sleep, but to be as active in darkness as in light.

The internal organization of these singular animals is not less interesting than their exterior form; and indeed it may be considered the more surprising, when their size, in comparison with that of the larger animals, is taken into consideration. Their movements are extremely multifarious, and for all these there is an appropriate system of muscles. These may be observed running in various directions, the most interesting being those which keep up the unceasing play of the vibrillæ. But these organs are not confined to this class, vibrillæ being found externally and internally in many of the higher animals.

In the Polygastrica Ehrenberg represents a long curved intestine with numerous globular bodies suspended to it somewhat like grapes, from the

mouth to the vent, which he regards as so many stomachs. This view passed undisputed for a considerable time; for although other observers failed to detect the connexion between the supposed stomachs and intestine, the failure was attributed to want of skill in microscopic manipulation. Ultimately this structure was doubted, although Pouchet reaffirmed it in 1848, and among others, Professor Rymer Jones expresses his doubts as follows:

"In carnivorous animalcules which devour other species, we might expect, were these the stomachs, that the prey would at once be conveyed into one or other of these cavities; yet, setting aside the difficulty which must manifestly occur in lodging large animalcules in these microscopic sacs, and having recourse to the result of actual experience, we have never in a single instance seen an animalcule, when swallowed, placed in such a position, but have repeatedly traced the prey into what seemed a cavity excavated in the general parenchyma of the body.

"In the second place, the sacculi have no appearance of being pedunculated, and consequently in a certain degree fixed in definite positions. . . So far from their having any appearance of connexion with a central canal, they are in continual circulation, moving slowly upwards along one side of the body, and in the opposite direction down the other, changing, moreover, their relative positions with each other, and resembling in every respect the colored granules visible in the gelatinous parenchyma of the hydra.

"With respect to the central canal, we have not in any instance been able to detect it . . . much less the branches represented as leading from it to the vesicles or stomachs, as they are called. Even the circumstances attending the prehension of food would lead us to imagine a different structure: witness, for example, the changes of form which *Enchelis pupa* undergoes when taking prey almost equal to itself in bulk. Such a capability of taking in and digesting a prey so disproportionate, would, in itself, go far to prove that the minute sacculi were not stomachs; as it evidently cannot be in one of these that digestion is accomplished."—*General Outline of the Animal Kingdom*, 1841.

The observations of Dujardin (Hist. nat. des Zooph. Infusoires, 1841) confirm those of Jones. He thinks that they do not lay eggs.

Many of Ehrenberg's discoveries were made by infusing indigo or carmine in the water in which he kept Infusoria, and this being swallowed, marked the limits of the internal cavity. He did not detect the liver, spleen, or organs of circulation and respiration; but there are two organs in the gullet supposed to be analogous to salivary glands.

All Infusoria live in the water, some being confined to fresh, and others to salt water; but there are others which inhabit both. Some swim about almost continually, some attach themselves at will to plants or animals, and others are attached to particular animals, as to the *Cyclops* or waterflea, the freshwater *Polypus;* and even upon or within other Infusoria. One species is found in the rectum of frogs, and another (*Paramecium compressum*) in the intestines of the earthworm. Agassiz has observed the eggs of *Planaria* producing a species of "*Paramecium*" which was consequently an immature condition of that animal. All the attempts of Ehrenberg to detect Infusoria as inhabitants of the air have failed.

The modes of locomotion in the Infusoria are various. Some swim by means of the vibrillæ; some, like the monads, revolve like a globe on its axis; others roll upon their transverse axis; others glide along with a regular motion like the snails; and others like the leech.

The reproduction of the Infusoria takes place by means of spontaneous division; by budding, which is the least common; and perhaps by the ordinary mode of generation, although this is denied by Dujardin, who affirms that there are no males; and indeed, no indications of sexual instinct have been observed among them. The first mode of reproduction occurs in the so-called Polygastrica, and takes place either transversely or longitudinally, each half forming an independent animal. The division is not always complete, and in this case the two parts remain attached to each other. Some present a singular peculiarity, in which the soft part alone of the animal is divided, whilst the harder parts or armor remain undivided, as in *Ophrydium versatile*, which often divides itself to the extent of millions, whilst the gelatinous exterior remains entire, although it increases in size. In others the protection is completely divided, whilst the animals remain more or less closely united. The division in pedunculated genera does not generally extend beyond the pedicle, which, in case the divisions are numerous, resembles the trunk of a small tree. This remarkable mode of reproduction by division proceeds with such rapidity under favorable circumstances, that a single animal may give rise to a million of descendants in the course of eight or ten days.

The sudden and unaccountable appearance of Infusoria, especially in closed vessels, was once attributed to spontaneous or equivocal generation, a theory which still has its defenders, although it appears to be pretty well ascertained that such a hypothesis is not necessary. We may readily imagine that the inconceivably minute eggs of such creatures (or of those of which these animalcula are the imperfect condition) can be raised into the air with vapor and transported in all directions, penetrating wherever the air itself finds access.

The vital power of some species (and of the crustaceous Rotifera) is so great that they can survive with so little moisture as to be considered dry, exhibiting no signs of vitality until moistened with a drop of water, when they resume their active life. Doyère found that they may be completely dried in sand, in the dry air, or in a vacuum, and be revived by placing them in water. When placed in water at the temperature of 50° Centigrade (=126° F.) they were killed, but would revive if the temperature did not exceed 45° or 48° Cent. Some species are said to occur naturally in warm springs whose temperature equals 40° or 50° Cent.; whilst some species are not destroyed by being frozen. Ehrenberg found Infusoria in materials taken from floating masses of ice, and in sea water from a depth of 1100 to 1600 feet, brought by Captain Ross from the regions towards the south pole, between the latitude of 63° and 78°, where the temperature must have been very low, and the light much reduced at such a depth.

The extent of certain geological strata made up of the solid parts of the Infusoria is extraordinary, when the minuteness of the aggregated particles

is considered; some of the silicious shields being so small, that, according to Ehrenberg, one hundred millions weigh but a grain. They are found in flint, semiopal, bog iron ore, ochre, tripoli (and other polishing minerals which owe their action to the shields of silicious species), mountain meal, a clay which is eaten in Lapland, and another variety in South America, but which probably merely fills the stomach without affording nourishment. Sometimes these remains form a stone sufficiently light to float in water, and strong enough to be employed in building. In Lüneburg and about Berlin, the infusorial strata are as much as twenty feet deep and twenty miles in extent. Infusorial strata have been discovered by William B. Rogers upon the Rappahannoc river at Stratford cliffs, on the Potomac, and on James River below City Point; and in other parts of Virginia. These deposits belong to the miocene formation.

The extent of the artificial group Infusoria will probably be much reduced as researches are continued. Kützing has separated the *Bacillaria* and *Diatomeæ* as *Algæ*, and he considers *Gaillonella ferruginea* to be a conferva. He thinks some of these organisms have both a vegetable and an animal nature, and that in such simple forms the distinction between animal and vegetable does not exist.

The observations of Unger, Flotow, Thuret, and C. Th. Siebold, have thrown doubts upon the animal nature of other Infusoria of the genera Enchelys, Chlamidomonas, Chilomonas, Chætoglena, and others. These researches seem to show that the spores of Algæ are locomotive by means of vibrillæ, although Unger and Bory would contend that these supposed spores are animal in their nature, but convertible into plants.

Agassiz considers many of the Infusoria to be the larvæ of worms, &c., and he seems disposed to suppress the entire class by distributing its members among the other classes of animal and vegetable nature. There is reason to believe that supposed species of Leucophra and Difflugia are immature Alcyonellæ. Neverthless, it would be premature to give up the entire class until a greater number of the more distinct forms are ascertained to be larvæ, because, whilst we admit that individual species may have been described under several distinct names, the number of infusorial species seems too great for the comparatively small number of worms, &c., likely to be derived from them.

The name *Infusoria* is adopted here on account of the heterogeneous contents of the division; but if future observation renders it probable that the removal of portions will still leave a distinct group incapable of union with other classes, these may take the more appropriate name of *Protozoa*, sometimes applied to the entire group; and its symbol, to extend the views of Agassiz, will be a circle.

Professor J. W. Bayley of the Military Academy, West Point, is the chief American authority upon the Infusoria. Most of his papers may be consulted in the American Journal of Science.

We now proceed to the consideration of the species figured in the atlas.

Anentera (without intestines).

Monas lens, Müller (*pl* 75, *fig.* 1), is about $\frac{1}{800}$th of a line long. The *line* used in Natural History is the twelfth part of a *French* inch.

Vibrio anguillula (*pl.* 75, *fig.* 7). This active species, which bears some resemblance to an eel, is found in vinegar and in sour paste, and can be revived after having been desiccated. It is by some placed among the worms, while Dr. Joseph Leidy, a distinguished comparative anatomist of Philadelphia, thinks their nature may be vegetable. His remarks, somewhat condensed, are as follows:

"Even those moving filamentary bodies belonging to the genus Vibrio, I am inclined to think, are of the character of algous vegetation. Their movement is no objection to this opinion, for much higher confervæ, as the Oscillatorias, are endowed with inherent power of movement, not very unlike that of the Vibrio. . . In the stomach and small intestine of the toad, *Bufo americanus*, there exist simple, delicate, filamentary bodies. One is exceedingly minute, forms a single spiral, is endowed with a power of rapid movement, and appears to be the *Spirillum undula* of Ehrenberg; the second is an exceedingly minute, straight, and short filament, with a movement actively molecular in character, and is probably the *Vibrio lineola* of the same author; the third consists of straight, motionless filaments, measuring $\frac{1}{1125}$ inch long, by $\frac{1}{15,000}$ broad; some were, however, twice, or even thrice this length, but then I could always detect one or two articulations, and these, in all their characters, excepting want of movement, resemble the Vibrio. In the rectum of the same animal, the same filamentary bodies are found, with myriads of *Bodo intestinalis;* but the third species, or longest of the filamentary bodies, have increased immensely in number, and now possess the movement peculiar to the *Vibrio lineola*, which, however, does not appear to be voluntary, but reactionary; they bend and pursue a straight course, until they meet with some obstacle, when they instantly move in the opposite direction, either extremity forward. But it must not be understood that these facts militate against the hypothesis of the production of contagious diseases through the agency of Cryptogamia. It is well established that there are microscopic Cryptogamia capable of producing and transmitting disease, as in the case of the Muscardine, &c."—*Proceed. Acad. Nat. Sci. for October*, 1849.

Vibrio tritici, which infests wheat, has been revived by moisture after being in a dry condition for six years.

Gonium pectorale (*pl.* 75, *fig.* 11, enlarged) is an interesting species, resembling a table-shaped mass, in which there are about sixteen green animalcula. When abundant they give a green color to the water.

Volvox globator (*fig.* 15, enlarged) was discovered by Leeuwenhoek in 1698, and is abundant in stagnant water. It is globular, of a pale-green color, and from one third to a sixth of a line in diameter. The surface is finely reticulated and provided with vibrillæ, by means of which it advances slowly through the water with a revolving motion. The Volvox is

sufficiently transparent to allow six or eight smaller bodies of the same nature, but of a darker-green color, to be seen moving freely about the interior, which are the young; and even these, towards the period of their exclusion, contain another set of germs. The rupture of the exterior of the large body sets the small ones free.

Bursaria vesiculosa (*fig.* 3) lives in the rectum of frogs; it is oval, and the margin is provided with vibrillæ: size one twentieth of a line.

Proteus diffluens (the genus has also been named *Amœba*) (*fig.* 2), seldom exceeds one twenty-fourth of a line in size. It resembles a mass of translucent jelly, which is continually changing its form from rounded to linear or cordate, sometimes projecting parts of the margin in various directions, so as to present a most varied outline.

Cyclidium glaucoma (*fig.* 8) is remarkable for its peculiar motion, which resembles that of the genus Gyrinus, a waterbug, which swims rapidly in circles on the surface of the water.

Trichodina cometa (*fig.* 14) is one twenty-fourth of a line long, and lives as a parasite upon the fresh-water polyps (*fig.* 21), of which it gnaws the arms, causing death.

Urocentrum turbo (*fig.* 13) has an oval-triangular, translucent body, and a stem about one third of its length. Length from one thirty-sixth to one twenty-fourth of a line. Found among duck-weed.

Carchesium polypinum (*fig.* 20) has a bell-shaped body, mounted upon a slender, spiral, branched stem, formed by incomplete division. Found among aquatic plants.

Enterodela (with the intestines evident).

Opercularia articulata (*pl.* 75, *fig.* 17) is composed of a stout-branched stem, two or three lines long, each of which supports a bell-shaped body, which is subject to variations in shape. It attaches itself to water insects, and is sometimes so abundant upon them as to present the appearance of a covering of mould.

Stentor mylleri (*fig.* 18) inhabits aquatic plants; when extended, it is shaped like a trumpet or funnel, but when contracted, it exhibits the form represented in the plate. Its length varies according to the amount of its contraction, from one tenth to one half a line.

Cryptomonas ovata (*fig.* 4) is a lengthened green body, one forty-eighth of a line long, provided with a delicate shield.

Bursaria truncatella (*fig.* 12) is somewhat egg-shaped, with one end deeply excavated: one fourth to one third of a line long.

Chilodon cucullatus (*fig.* 10) is somewhat lengthened, flat, and rounded, with a small projection in front. Common in stagnant water.

Trachelocerca olor (*fig.* 5) takes its trivial name from the distant resemblance it bears to a swan. It lives among duck-weed and conferva, and is from one twenty-fourth to one twentieth of a line long.

Trachelocerca viridis (*fig.* 6) is more rare than the preceding, and inhabits the same places. It takes its trivial name from the green germs within it.

Paramecium compressum (*fig.* 9), already alluded to, is from one twentieth to one twenty-fourth of a line long, and is probably an early stage of Planaria.

The structure of the two next species figured among the Infusoria shows that they are *Crustacea*. The first is *Rotifer vulgaris* (*pl.* 75, *fig.* 16), remarkable for the two circles of vibrillæ already referred to, and for the posterior forceps by which it attaches itself. *Melicerta ringens* (*fig.* 19) can withdraw itself into an external case; it lives in society, and has the vibrillæ distributed in four divisions.

Division I. Radiata.

The radiated division of the animal kingdom, in the arrangement of Agassiz, and to a certain extent, in that of Milne Edwards, includes all those forms in which the radiated structure is more or less evident, as in the Zoophyta, the Medusæ, and the Echinodermata. In Cuvier's arrangement, the Zoophyta (under which term he includes all the Radiata) are a heterogeneous assemblage of radiated forms, Epizoic Crustacea, Intestinal Worms, and Infusoria.

"In a general point of view, we may, however, compare further, all radiated animals, when we shall find that they really constitute a natural, well circumscribed group in the animal kingdom, agreeing in all important points of their structure, being strictly constructed upon the same plan, although the three classes which we refer to this great department differ in the manner in which the plan is carried out."—*Agassiz's Lectures on Embryology*, Boston, 1849. P. 43.

The Radiata are distributed into three classes, *Colenterata*, *Zoophyta*, and *Echinodermata*. The first includes the Acalephæ or Medusæ, to which the Hydroida are added; the second the Zoophyta, excluding the Hydroida; and the third the Echinodermata.

The Hydroida have been usually placed in the class Zoophyta, although in the development of some of the families in which it has been observed, they present characters indicating a great affinity with the Acalephæ, which in their turn have been regarded as an individual class. In dismembering the Zoophyta to unite the Hydroida and Acalephæ, we may either apply the name of the latter to the united group, or choose a distinct one. The latter course is preferable, being least likely to cause confusion, and we have accordingly adopted the name proposed by Fry and Leuckart. The necessity of this union is insisted upon by Forbes in his British Naked-eyed Medusæ, p. 82; and in Agassiz's Lectures on Embryology, p. 44.

Class 1. *Colenterata.*

This class contains the orders Hydroida, Pulmonigrada, Ciliograda, Cirrigrada, Physograda, and Diphyida, all of which (excepting the first) constitute the Acalephæ of Cuvier. For the sake of uniformity in the nomenclature, we here propose the name *Systoligrada*, instead of *Diphyida*, the locomotion being similar to that of the Pulmonigrada.

Order 1. Hydroida. The order Hydroida contains animals, some of which have, and some have not a corallum, or the stony material named *coral*. This does not constitute an essential distinction here, or among the Zoophyta, because the condition of the hard material is different in different genera, being sometimes merely indicated by the presence of calcareous granules scattered through the body.

In the Hydroida the internal cavity is tubular and simple, and the order includes the four *families*, Hydridæ, Sertularidæ, Campanularidæ, and Tubularidæ.

The *Hydridæ*, of which the fresh water polypus is a familiar example, occur in America as well as in Europe. It forms the genus *Hydra*, and is a soft naked polyp (*pl.* 75, *figs.* 21–23) found attached to plants in stagnant water, and increasing by lateral buds, as represented in *figs.* 22, 23; but unlike some Zoophyta, the young thus produced become detached when they attain a certain size. The internal cavity of the young is for some time continuous with that of the parent, so that the nourishment taken by the latter can be digested by both. Finally the young gets arms of its own, the cavity closes below, and the new animal becomes detached and commences an independent life. This mode of increase takes place in summer. Trembley, by watching an individual, found that it produced forty-five young in two months.

This genus was discovered in Europe by Trembley, in the year 1739, and we have observed it here. It attaches itself by the base to plants, rubbish, or even aquatic insects. These animals move somewhat in the manner of a leech, by stretching out the body and attaching the arms to an object, then drawing up and attaching the base, and so on in succession. When placed in a glass of water, they are said to pass from the shade into the light. The figures represent them about the natural size, so that they can be pretty readily detected with the naked eye. When disturbed, the arms and body are contracted into a small compass. The arms are used to catch their prey, which consists of minute Crustacea, and other animal food. The body is usually sufficiently translucent to allow the contents of the internal cavity to be seen.

The structure of the Hydra is of the simplest kind, being limited to the tubular body and its single aperture for the admission and exclusion of food; and the margin of this opening is fringed with from six to eighteen very elastic, flexible, and thread-like arms.

Under a high magnifying power, the arms of Hydra are seen to be studded with hemispherical projections, which resemble a bunch of grapes when

they are drawn together by the contraction of the arms. Most of these projections support a short hair, some are armed with a thorn, and others support a very long hair ending with a spur composed of several thorns around a pear-shaped mass. See the last edition of the Règne Animal, Zoophytes, *pl.* 64.

It is evident that the Hydræ, like the Medusæ or sea nettles, have a stinging power, judging from the manner in which their prey is paralyzed when seized. Worms which will live and move for some time when cut into fragments, die instantly when seized by a hydra: and if a worm which has been seized is taken from the animal before it is swallowed, it does not revive. When a minute animal comes within reach of one of the arms, it is seized and swallowed, and this sometimes happens to young fishes. They sometimes even swallow each other, but the swallowed individual is cast out again unhurt. The uniformity of structure is proved by the fact that if the animal is turned inside out, the food can be digested by what was once the outside.

The genus Hydra has been named after the fabulous monster of antiquity bearing the same name, because parts cut away will be reproduced; and under favorable circumstances, when an individual is divided into several parts, each part will become a perfect animal. It is probable that *Hydra grisea* (*pl.* 75, *fig.* 21), *H. fusca* (*fig.* 22), and *H. viridis* (*fig.* 23), are varieties of but a single species.

The order Hydroida, according to Mr. Dana, contains the following families:

1. *Hydridæ.* Not coralligenous.

2. *Sertularidæ.* Coralla corneous. *Sertularia abietina* (*pl.* 75, *fig.* 33). *S. polyzonalis* (*fig.* 30). *S. operculata* (*fig.* 34). *Planularia falcata* (*fig.* 31). *Thuiaria thuia* (*fig.* 32), all European.

"In a single specimen of *Plumularia angulosa* collected by the author in the East Indies, there are about 12,000 polyps to each plumose branch; and, as the whole zoophyte, three feet long, bears these plumes on an average every half inch, on opposite sides, the whole number of polyps is not short of eight millions; all the offspring of a single germ, and produced by successive budding."—*Dana.*

3. *Campanularidæ.* Coralla corneous, calicles pedicillate.

4. *Tabularidæ.* Coralla tubular and corneous. *Tabularia indivisa* (*pl.* 75, *fig.* 42) (Atlantic and Mediterranean), attached to stones in deep water, *T. coronata* (*pl.* 75, *fig.* 29) (Northern seas). Stem one third of a line in diameter. In this genus the tentacles are not retractile.

The remaining orders of the class Colenterata were called Acalephæ by Cuvier, from the Greek word ακαληφη a *nettle*, from the stinging quality which many of these animals possess. Blainville gave them the expressive name of *Arachnoderma*, from αραχνιον a *cobweb*, and δερμα the *skin*, from the extreme tenuity of the tissues. They are also termed Medusæ, sea-nettles, stang-fishes, sea-jellies, and jelly-fish. They are found floating in all seas, particularly those of the tropics; their size varies from one sixth of a line to

two feet, and the weight of large ones reaches fifty or sixty pounds. Yet this great mass is composed almost entirely of water, which pervades the tissues, and these are of such extreme tenuity that the weight of one of these masses is reduced by desiccation to grains instead of pounds.

The more familiar forms belong to the Pulmonigrada, also termed Discophora, which may be compared to an expanded umbrella, or to a mushroom, the alternate contraction and expansion of which enable the body to move through the water with the convex or upper surface foremost; a mode of progression which has afforded a name to the order, from its resemblance to the action of lungs.

The beauty of many of these animals equals anything in organic nature; the colors are prismatic or entirely wanting, and in the latter case, the gelatinous transparent body resembles a mass of colorless liquid gum, which can only be distinguished by its motions from the water which surrounds it.

"When in a jar or basin they are often very difficult to distinguish, but by placing the vessel in the sun, we see their shadows floating over the sides and bottom like the shadows of flitting clouds on a landscape. These soon guide us to the creatures themselves, and before long we distinguish their ocelli and colored reproductive organs."—*Forbes.*

The disk forming the greater part of the body varies from hemispherical to flattened discoidal, and is sometimes lengthened into a conical or subcylindrical form. The central portion is thickest, and the inferior surface is concave. The margin is either entire or fringed with tentacles, which vary greatly in length, number, and form. Some of these tentacles have a colored spot at their base called an ocellus, and upon this Forbes has divided the Discophora into two groups; namely, the *Steganophthalmata* (covered eyes), in which the ocelli are protected by membranous lobes, and the *Gymnophthalmata* (naked eyes), in which the ocelli are not protected. The former are more highly organized than the latter, and in most of the genera the sexes are not united in the same individual. Agassiz has discovered a nervous ring around the mouth, with branches extending to the ocelli; an arrangement which resembles that in the Echinodermata. Ehrenberg had made a less distinct announcement, and Dr. Grant announced the discovery of a nervous system in Beroe, in the year 1833.

From the centre of the concavity of the disk arises the peduncle, which varies much in size and shape, in some genera forming a considerable portion of the animal, and in others being reduced to a slender extensile and contractile tube, at the extremity of which the mouth is situated. The cavity of the peduncle, or its base, is the stomach, whence branches are sent towards the disk, around the margin of which there is a canal connecting with them. These radiating gastro-vascular branches vary in number from four to twelve or more. In the naked-eyed genera they are seldom branched; and when they are, the branches run to the marginal canal, as in the genus Wilsia* (Forbes, Monog. of the British Naked-eyed Medusæ

* Named after Dr. Will, who wrote on this subject.

London, 1848, *pl.* 1, *fig.* 1). The same structure occurs in Berenice (Cuv. Règne An. Zooph., *pl.* 53, *fig.* 1[a]). In the covered-eyed group, the branches after extending about two thirds the distance towards the edge anastomose around the margin in a broad and close vascular net-work (beautifully exhibited in Milne Edwards' figure of Rhizostoma, R. An. *pl.* 50).

The position of the generative system is variable in this class. In general both sexes seem to be united in the same individual.

When the ocelli are present, the sense of sight is probably sufficient to enable the animal to distinguish between light and darkness, and the sense of hearing may also be present. Their food is furnished by small marine animals, among which the crustacea fill a prominent place. The sense of feeling is probably most developed in the palpi, the tentacles, and the arms, arising from the centre, and surrounding the mouth or pedicle.

The stinging quality is not universal in the Medusæ, being apparently confined to a few of the higher forms. Bathers sometimes suffer severely by coming in contact with the larger species, whose long tentacles and arms are sometimes entangled around the limbs, and cast off by the animal, leaving the sufferer to disengage himself from these unwelcome appendages at his leisure. The stinging property is supposed to be confined to an external coat of mucus, which the animal can cast off.

The luminousness of the sea is due chiefly to multitudes of acalephæ.

"At one time, the evening serene and delightful, a pleasant breeze just filling the sails, and the bow of the vessel throwing the water to each side, as it gracefully parts the yielding waves, all round the ship, far as the eye can reach, may be seen innumerable bright spots of light rising to the surface, and again disappearing, like a host of small stars dancing and sparkling on the bosom of the sea. At another time, the night dark and lowering, a fresh breeze urging the ship rapidly onwards through her pathless track, upon looking over the stern, in addition to the smaller specks just now mentioned, large globes of living fire may be seen dancing in the smooth water in the wake of the rudder; now, at a great depth, shining through the water, then rising rapidly to the surface, they may be seen, as they reach the top of the wave, flashing a bright spark of light, sufficient almost to dazzle the eyes of the beholder; and now, again, they may be traced floating majestically along, till they gradually disappear in the darkness of the water in the distance. At other times, again, when light rain is falling, or, perhaps, previously to the rain coming on, when a light nimbose cloud is overspreading the sky, upon the water being agitated by the ship passing through it, a beautiful general luminousness is diffused all round, bright enough to illuminate the whole ship's side, and the lower large sails; and it is no unusual occurrence to have the appearance so bright, that a person with little difficulty, and near the surface of the water, might be enabled to read a book by its aid. . . It is in warmer regions and more southerly latitudes that this phenomenon attains its greatest degree of brilliancy and beauty."—*W. Baird*, *On the Luminousness of the Sea, with figures. Mag. Nat. Hist.* 1830, vol. 3, p. 308; vol. 4, p. 500. *See also* vol. 6, pp. 314–319.

Luminous acalephæ occur upon the coast of the United States, and they may be observed on a night passage in a steamboat in Long Island Sound.

The light is usually produced under exciting circumstances, or when the animal is disturbed, and all parts do not produce light. Spallanzani found that in cutting off the margin for about half an inch, the latter remained phosphorescent, which was not the case with the disk.

ORDER 2. PULMONIGRADA. The following species of this order are figured; *Thaumantias cymbaloidea* (*pl.* 76, *fig.* 73), Northern Seas. *Aurelia aurita*, Linn. (*fig.* 74), Northern Seas; six to ten or eleven inches in diameter. In this genus the mouth is surrounded with four arms, and the central peduncle is wanting. This species has a bluish disk, fringed with slender tentacles, and having eight marginal ocelli, which are black, with a red point above. Beneath there are four long fringed central arms, with the mouth between them. Sometimes the margin of the arms contains eggs. The ovaries, however, have their openings between the base of each pair of arms; there are four of them shaped like a horse-shoe, and of a purple color, which renders them visible from above, as seen in the figure.

ORDER 3. CILIOGRADA. This order (also named Ctenophora by Eschscholtz) is named from its organs of motion, which consist of a series of flat phosphorescent vibrillæ, arranged longitudinally upon the surface of the body, along the eight ribs, and by the action of which progression is effected. These vibrillæ are arranged with their flat surfaces nearly in contact, and they are raised slowly and struck rapidly. Some authors suppose them to subserve the purpose of gills as well as organs of locomotion. The genus Beroe, which is a good example, varies in form from globular to cylindrical, but a little compressed. The cavity beneath is very large, and the animal moves with the mouth foremost. In addition to the mouth there is an exceretory orifice. *Cestum veneris* has a ribbon-shaped body, the two margins of which are fringed with beautifully colored phosphorescent vibrillæ, which at night give the animal the appearance of a band of flame, as it moves through the water. It attains the length of three or four feet.

ORDER 4. CIRRIGRADA. The form is discoidal, and there is an internal subcartilaginous discoidal skeleton, which distinguishes them from the Pulmonigrada. In *Porpita* (*pl.* 76, *fig.* 83) the margin is fringed with stout claviform tentacles, provided with three ranges of pedunculated glands or suckers. The stomachal pedicle is large, and surrounded by numerous tentaculiform cirri, by means of which locomotion is effected. These bear some resemblance to the tentacles of the Actiniæ, to which Blainville thinks the order has some affinities. In Velella (*V. spirans*, Forsk., *pl.* 76, *fig.* 84), besides an oval cartilaginous skeleton, there is a vertical process arising from it which supports a crest-like membrane.

ORDER 5. PHYSOGRADA. This order was called Hydrostatic Acalephæ by Cuvier, a designation which, like the proper name, points to a peculiarity of structure, namely, the support of the body by one or more air-vessels, which cause the animal to float. *Physalia physalis*, Linn. (*pl.* 77, *fig.* 1), possesses stinging qualities; it inhabits the Gulf of Mexico and the Atlantic, and is known to sailors as the Portuguese man-of-war. The air-vessel is very large, and has a small aperture at each end, from which the air can be

expelled when the animal wishes to sink. It is probable that this may be accomplished to a certain extent by the muscular power of the air-vessel. Blainville thinks that this order (which wants the radiated character), with Beroe and Diphyes, may be allied to the Mollusca, and in the year 1836 he proposed for them the name *Malactinozoaria*, under the impression that they constitute an intermediate division.

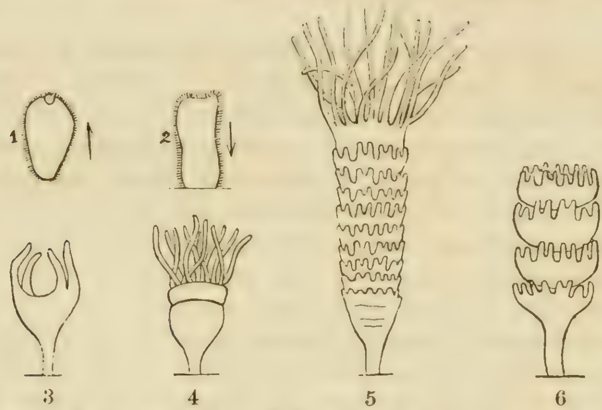
ORDER 6. SYSTOLIGRADA. The name Diphyida is derived from that of the genus Diphyes, in allusion to its double nature, each animal being composed of two somewhat conical pieces, the point of one being inserted a short distance into the larger end of the other, and retained by a very slight attachment. See the Penny Cyclopædia for an extended account, illustrated with figures of this and the preceding orders.

SARS, a distinguished naturalist of Norway, discovered in 1836 that some of the Acalephæ resemble the Zoophyta, in having a gemmiparous reproduction. He observed certain projections from the base of the pedicle (or exterior of the stomach), which proved to be budding young, attached by the upper or outside portion of their disk. These young resemble the adult in all essential particulars, and, like the Hydræ, they have an independent action previous to their separation from the parent. This is represented at *a*, in the annexed figure of *Lizia octopunctata* of Sars (an animal about one fourth of an inch long), as given by Forbes. The species is named from the eight black ocelli, four of which are large, and towards these the gastric vessels are directed. In *Sarsia prolifera*, Forbes, the gemmation takes place at the base of the exterior tentacles.

We come now to describe a mode of generation which has no parallel in the higher animal forms, and to which the Medusæ and some other animals are subject. This mode is termed *Alternation of generations* by the Danish naturalist, Steenstrup, who has the credit of generalizing the facts upon which the theory is founded, and of which he is in part the discoverer. An English translation of his work on the subject, by George Busk, was published by the Ray Society in 1845, entitled, "On the Alternation of Generations; or the Propagation and Development of Animals through Alternate Generations: a peculiar form of fostering the young in the lower classes of animals." Besides this author, the chief observers in this curious branch of science are Chamisso, who published observations on the Salpæ in 1819; Sars, on the Medusæ, between 1828 and 1841; Siebold and Lovén in 1837; and Van Beneden in 1844–7. (See the Cyclop. of Anat. and Phys., Art. *Polypifera*.)

This phenomenon is described by Steenstrup as that of "an animal producing an offspring, which at no time resembles its parent, but which,

on the other hand, itself brings forth a progeny, which returns in its form and nature to the parent animal, so that the maternal animal does not meet with its resemblance in its own brood, but in its descendants of the second, third, or fourth degree or generation; and this always takes place in the different animals which exhibit the phenomenon in a *determinate* generation, or with the intervention of a *determinate* number of generations. This remarkable *precedence* of one or more generations, whose function it is, as it were, to prepare the way for the later succeeding generation of animals, destined to attain a higher degree of perfection, and which are developed into the form of the mother, and propagate the species by means of ova, can, I believe, be demonstrated in not a few instances in the animal kingdom."

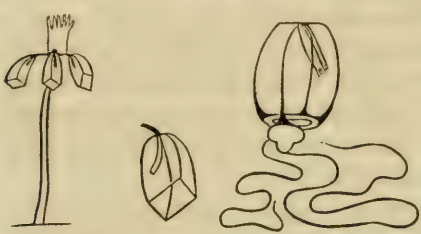


When a medusa, as *Aurelia aurita* (*pl.* 76, *fig* 74), produces an egg, the progeny resembles an animalcule (Diagram, *fig.* 1), which moves in the direction of the arrow by means of vibrillæ. The anterior extremity has a round sucker (but not a mouth), by means of which, after several changes of form, it attaches itself to some extraneous object (Diagram, *fig.* 2). The changes still continue, the two projections at the free end are extended, a mouth is formed in the centre, and a second pair of projections arises between the first. About the fifth or sixth day the four tentacles have become longer, and the body quadrate, and the animal now constitutes the supposed perfect genus, *Scyphistoma* (Diagram, *fig.* 3), of Sars. In the next place, four additional tentacles arise between the four earlier ones, and this production continues until the number equals twenty-eight or thirty, and by this time the animal resembles a polyp.

In the subsequent changes an entirely new phenomenon is observable. The free extremity of the body begins to show indications of a division into segments, of which one is shown in Diagram, *fig.* 4; the length and number of segments increase, the body becomes cylindrical, and is now about a line in diameter (its original size being that of a grain of sand), the upper margin of the segments becomes free and divided into lobes (Diagram, *fig.* 5), capable of independent motion, when the form constitutes the supposed genus, *Strobila*, of Sars, named from its resemblance to the cones of a pine tree.

Finally, the union between the segments is more and more reduced, until they separate like a pile of hemispherical cups, as in Diagram, *fig.* 6, when they are seen to be separate animals in an inverted position; in fact, the young or larvæ of *Aurelia* (*pl.* 76, *fig.* 74). These larvæ (constituting the supposed genus *Ephyra*) are about a line in width, and continue growing and passing through such a change as to give it the structure of the adult, which it acquires when about an inch in size. It is not precisely known what becomes of the polypiform head of the *Strobila* (Diagram, *fig.* 5), but the base is said to produce a new set.

It appears from these facts that the animal (Diagram, *fig.* 1) hatched from the egg of a medusa, does not become a free medusa, but a kind of polyp, *Scaphistoma strobila*, which does not produce its like, but from which medusæ are developed. The polypoid *nurse*, as it has been termed, is uniformly an undeveloped female, whilst of the resulting medusæ, some are male and some female. The nurse, like the adult medusa, has the power of increase by budding.



1 2 3

The annexed *fig.* 1 represents an individual of the presumptive genus *Coryne*, placed in the family Tubularidæ (p. 27). The head is a six-armed hydroid, beneath which are four quadrate, bell-shaped bodies, which are not organs, but distinct individuals of an entirely different form from the hydroid. In the concavity of each is suspended a quadrate stomach, as shown in *fig.* 2. These bodies have an independent motion, sucking the water in, and throwing it out like the Medusæ. They finally detach themselves, and swim freely like medusæ, to which they bear a close resemblance. Steenstrup, who observed this species in Iceland, found larger individuals (*fig.* 3), which he considers the adult medusaform of the former, in which one of the angles bears a lobed organ and two threads, which he regards as female generative organs. Steenstrup regards *Coryne* as "a previous generation of preparative *nurses*, which are so far asexual, inasmuch as that their generative organs are not developed."

Forbes describes two minute British species allied to *fig.* 3, under the generic name of Steenstrupia, suggesting that they may be a stage in the history of some hydroid form.

Class 2. *Zoophyta.*

The Zoophyta are chiefly marine; some species are sedentary and others free, some live as single independent animals, and others are collected together in large colonies, the base of the stems being united. Some are without a hard support, others secrete a stony skeleton, which is named *coral* (CORALLUM, CORALLA in the plural).

The corallum is not usually external like the shell in the Mollusca, as is popularly supposed, but an internal secretion "entirely concealed," in the

words of Dana, "within the polyp, as completely as the skull of an animal beneath its fleshy covering. All corals are more or less cellular, and through these cellules the animal tissues extend." In some, however, the coral is exposed, as when the increase takes place by a terminal secretion upon a separate stem, when the apex alone is living, and as the stem increases in length the part below dies. This increase above and death below are common in most corals, and to this the great masses of coral are attributable. According to Dana, a solid dome of Astræa, twelve feet in diameter, has a living exterior of only a half or three fourths of an inch in thickness.

The classification adopted here is chiefly that of James D. Dana, as given in his magnificent work on Zoophytes, the result of his labors in the United States Exploring Expedition. The characters of the families are in most cases condensed from the same work.

The Order Actinoida includes not only the flower-shaped genera, like *Actinia* (*pl.* 77, *figs.* 5, 6), which do not secrete a coral, but also numerous coralligenous genera. The name of this order, from the Greek ακτιν, a ray, is in allusion to the radiated arrangement of the tentacles, which, when expanded, in many cases resemble the petals of a flower. When contracted this resemblance disappears, and the mass may be compared to a lemon in shape. Lesueur has described a species (*A. marginata*) from Massachusetts Bay. (Jour. Acad. Nat. Sci. i. 172.)

The Actiniæ are found in the sea, attached to stones, submerged timber, &c. They have the power of detaching themselves and floating, and of creeping slowly upon their flat base, at the rate of about two inches in an hour. The texture of the exterior is either fleshy or coriaceous, the surface slimy, smooth, or tuberculous, and very sensitive. The mouth is simple, and fringed by the tentacles. These organs being tubular, they are expanded by having water forced into them, and when they contract, the water is ejected through a minute terminal perforation. The tentacles of some species resemble the Acalephæ in having a stinging power.

The interior of the Actiniæ is taken up with the stomach, which is a simple sac, of which the mouth is the opening, and extending nearly to the base of the animal, where it communicates with the visceral cavity, occupying the space between the stomach and the exterior wall. The cavity is provided with a series of vertical muscular partitions, more or less perfect, which extend from the exterior wall to the stomach, so that a transverse section of the animal would resemble a wheel, of which the nave would represent the stomach, and the spokes the visceral partitions.

The Actiniæ feed upon fish, crabs, shell-fish, &c., the shells and other indigestible parts being ejected from the mouth after a period of ten or twelve hours. A large individual sometimes accidentally swallows a smaller one, but the latter is usually cast out unharmed, as in the case of the Hydra. The objects swallowed are sometimes as large as the Actinia itself in a state of repose. The following account is given in G. Johnston's excellent History of British Zoophytes.

"I had once brought me a specimen of *Act. gemmacea*, that might have

been originally two inches in diameter, and that had somehow contrived to swallow a valve of *Pecten maximus* of the size of an ordinary saucer. The shell, fixed within the stomach, was so placed as to divide it completely into two halves, so that the body, stretched tensely over, had become thin and flattened like a pancake. All communication between the inferior portion of the stomach and the mouth was, of course, prevented; yet, instead of emaciating and dying of an atrophy, the animal had availed itself of what undoubtedly had been a very untoward accident, to increase its enjoyments and its chances of double fare. A new mouth, furnished with two rows of numerous tentacula, was opened upon what had been the base, and led to the under stomach; the individual had, indeed, become a sort of Siamese twin, but with greater intimacy and extent in its unions!"

The Actiniæ are hermaphrodite; the reproduction is both by division and by eggs; and the eggs or young (as the case may be) are ejected through the mouth, or rarely, by a kind of abortion, through the tentacles, according to Contarini. The young do not differ essentially from the adult, the chief difference being in the small number of their tentacles.

The Actiniæ reproduce lost parts, especially the tentacles, with great facility; and when the body is cut into two, three, or even four parts, each may survive and become a complete animal. If the section is horizontal, the lower part acquires a new mouth and tentacles, and the upper part a new base, although in one instance the latter produced a second mouth, so that food was taken at both extremities of the new animal. These experiments indicate that the base has the greatest vital power. (See Contarini, *Trat. delle Attinie*, &c., Agassiz's Lectures, and Johnston's Zooph.)

Actiniæ will survive after being placed in water hot enough to blister the skin, and they may be frozen and thawed with impunity, but immersion for a few minutes in fresh water kills them.

The order Actinoida contains the sub-orders Actinaria and Alcyonaria, and the families, according to Dana, are as follows:

Sub-order 1. Actinaria.

Often coralligenous, cells lamelliradiate.

Tribe 1. *Astræacea.*

Many tentacles in imperfect series; coralla calcareous, with multiradiate cells, with the lamellæ extending beyond the cells.

Fam. 1. *Actinidæ.* Not coralligenous, usually attached, but sometimes floating in the sea. *Actinia* (*pl.* 77, *figs.* 5, 8). *Lucernaria* (*pl.* 76, *fig.* 72). (Johnst. Zooph., p. 228. R. An. *pl.* 63, with anatomical details.)

Fam. 2. *Astræidæ.* Coralla calcareous, tentacles marginal, coralla with excavate cells, stars circumscribed. *Astrea astroites* (*pl.* 75, *fig.* 62). *Meandrina labyrinthica*, Linn. (*pl.* 75, *fig.* 64); hemispherical, with long winding lines: American seas.

Fam. 3. *Fungidæ.* Disks not circumscribed, tentacles scattered, short, or obsolete; simple or aggregate-gemmate; when aggregate the disks are confluent; surface of the coralla stellate, without proper cells. *Fungia fungites*, Linn. (*pl.* 75, *fig.* 65), has a circular coral, with radiating lamellæ, like the under surface of some mushrooms; beneath granulated.

A common species from the Indian Ocean and Red Sea. In this genus the corallum is formed by a single polyp, which covers it beneath as well as above. The tentacles are scattered, and when touched, are withdrawn between the lamellæ.

Tribe 2. *Caryophyllacea.*

Tentacles numerous, in two series; coralla calcareous, cells multiradiate, interstitial surface not lamello-striate. The fourth family is not coralligenous.

Fam. 1. *Cyathophyllidæ.* Interior middle of each corallum usually transversely or obliquely cellular.

Fam. 2. *Caryophyllidæ.* Tentacles crowded and long, mouths far exserted; interior of the corallum not transversely cellular, rays of the cells more than twelve. *Oculina virginea*, Linn. (*pl.* 75, *fig.* 58). White, eighteen inches high, East and West Indies and the Mediterranean. *O. gemmascens* (*pl.* 75, *fig.* 59). White, eight inches high.

Fam. 3. *Gemmiporidæ.* Tentacles short and marginal, in two or three series; disk broad, somewhat convex; coralla porous, calicles with a thick margin. ? *Explanaria ananas* (*pl.* 75, *fig.* 63).

Fam. 4. *Zoanthidæ.* Exterior subcoriaceous, tentacles short and marginal, in two or three series.

Tribe 3. *Madreporacea.*

Tentacles in a single series, seldom more than twelve, sometimes obsolete; coralla calcareous, cells small, six- to twelve-rayed, or obsolete; interstitial surface not lamello-striate.

Fam. 1. *Madreporidæ.* Tentacles twelve; cells deep, extending to the centre of the corallum. *Madrepora prolifera* (*pl.* 75, *fig.* 60).

Fam. 2. *Favositidæ.* Tentacles twelve; lime secreted periodically at base, so that the interior of the corallum is septate, rarely solid. *Pocillopora polymorpha* (*pl.* 75, *fig.* 55). (Lamarck, 2, 311.) Red Sea.

Fam. 3. *Poritidæ.* Tentacles rarely more than twelve; base forming porous calcareous secretions beneath; coralla finely porous, cells shallow, rays indistinct. *Porites porites*, Linn. (*P. clavaria*, Blainv.) (*pl.* 75, *fig.* 61). American and Indian seas.

Tribe 4. *Antipathacea.*

Animals six-tentaculate, base forming corneous secretions.

Fam. 1. *Antipathidæ.* Animals fleshy, enveloping a corneous spinulous axis. *Antipathes spiralis* (*pl.* 75, *fig.* 51); stem entire, long, and spiral, about as thick as a quill, and attaining a length of sixteen feet. Indian Ocean.

Sub-order 2. Alcyonaria.

Eight-tentaculate; tentacles papillose, apex of the papillæ perforate; often coralligenous.

Tribe 1. *Alcyonacea.*

Fam. 1. *Pennatulidæ.* Free, or with the base sunk in the mud. *Pennatula phosphorea*, Linn. (*pl.* 75, *fig.* 26). Bears some resemblance to a quill. It is found in the European seas, and emits a pale-blue phosphorescent light when disturbed. *P. granulosa*, Lam. (*fig.* 25), and

P. grisea, Esper (*fig.* 27), inhabit the Mediterranean; *Virgularia juncea*, Esper (*fig.* 24), Europe.

Fam. 2. *Alcyonidæ.* Fleshy, with calcareous granules. *Alcyonium ficiforme* (*pl.* 75, *fig.* 46), size and shape of a fig, and of a yellowish-brown color; and *A. palmatum* (*fig.* 47), stem divided irregularly, somewhat like a hand; pale-red. Mediterranean.

Fam. 3. *Cornularidæ.* With corneous tubular coralla.

Fam. 4. *Tubiporidæ.* With calcareous tubular coralla. *Tubipora musica* (*pl.* 75, *fig.* 66) is of a fine red color, the body green. Indian seas.

Fam. 5. *Gorgonidæ.* With basal epidermic secretions. *Gorgonia flabellum* (*pl.* 75, *fig.* 48). Reticulate, branches inwardly compressed; three feet long. Warm seas of India and America. *G. verrucosa*, Linn. (*pl.* 75, *fig.* 49). Atlantic, six to twelve inches. *G. ceratophyta* (*fig.* 50), Mediterranean. *Isis hippuris*, Linn. (*fig.* 53); stem jointed and strong, branches dichotomous. East Indies. *Coralium nobile*, Linn. (*pl.* 75, *fig.* 52), is branched, one foot high, varies from a fine deep-red to a rose color, or white with a reddish tinge. It admits of a fine polish, and is much used for light ornamental work. When fresh, the exterior is fleshy and polypiferous, which, in drying, forms a crust with scattered cellules.

The forms of the corals which most of the zoophyta secrete, are extremely varied; representing various plants and mosses, variously shaped vessels, domes, obelisks, radiated disks, leaves, &c.; and the size of the coral mass varies from a few lines to twelve or even twenty feet. The large masses have commenced in a single animal, from the successive budding of which, the whole has resulted.

"Calculating the number of polyps that are united in a single Astræa dome of twelve feet diameter, each covering a square half inch, we find it exceeding 100,000; and in a Porites of the same dimensions, in which the animals are under a line in breadth, the number exceeds five and a half millions. There are here, consequently, five and a half millions of mouths and stomachs to a single zoophyte, contributing together to the growth of the mass, by eating, and growing, and budding, and connected with one another by their lateral tissues and an imperfect cellular or lacunal communication."—*Dana*, p. 60.

In those cases where single polyps occupy the extremity of dead branching stems, there is no union of the soft parts of different individuals.

Class 3. *Echinodermata.*

The Echinodermata, which are all marine, and include what are popularly termed star-fish, sea eggs, &c., are the most highly organized class in the radiated division of the animal kingdom. The bodies of some are raised upon a pedicle, the base of which is fixed to a single place; others are without a pedicle, and move freely and slowly along the bottom. Some of the latter are provided with a multitude of sucker-like feet, which, in *Asterias aurantiaca*, amount to 840, according to Tiedemann. Some are provided with eye dots, which, in Asterias, &c., are situated at the extremity of the rays; and where the nervous system has been detected, it forms a circle

around the œsophagus, with branches to the rays, &c. The mouth is armed with hard bony teeth, enabling the animal to live upon crustacea and shell fish. Some live at the bottom of the sea on the surface of the rock, and others burrow in the sand.

The integument of some of the members of this class is sustained by a calcareous skeleton, which incloses the viscera and supports movable spines varying much in size and shape. The skeleton is composed of pieces which are often joined together like polygonal stones in a pavement. These plates, the spines, and the entire skeletons, are very abundant in various geological formations, in which they are preserved in great perfection.

The class contains the orders Crinoidea, Asteridea, Echinidea, Holothuridea, to which some add another for the reception of Siponculus, Echiurus, &c., constituting the apodous Echinodermata of Cuvier.

Order 1. Crinoidea. This order is almost extinct, but is found plentifully in a fossil state in the older rocks. These remains consist of the solid calcareous skeleton, of which the chief parts are the stem, the body, and the arms. The body is oval or cup-shaped, protecting the internal soft parts, and made up of numerous plates, of which the variations in number and form afford generic characters. The arms are five or more in number, simple or branched, fringed with lateral articulated appendages, and placed around the upper margin of the body, the mouth being situated between them. When the arms are closed, some species resemble a lily, whence the trivial name of *Encrinus liliiformis*. The vent is distinct and lateral.

The central solid part of the stem has been compared to the bones in a lizard's tail, being made up of a column of disks, which are either circular, polygonal, or star-shaped. The stem is often provided with articulated simple lateral branches, which, like the arms, are filled with calcareous joints, many thousand of which are contained in the remains of a single animal. The disks of the stem have a perforation through them, which admits of their being strung like beads; and, according to Dr. Buckland, they were used for rosaries in ancient times. In northern England they are called St. Cuthbert's beads; and before their nature was known, they were named Entrochites in books.

Pentacrinus asteria, Linn. (*P. caputmedusæ*, Miller) (*pl.* 76, *fig.* 58), is a recent species from the West Indies, of which a specimen is in the British Museum, the Paris Museum, that of the Geological Society of London, and that of the London College of Surgeons. (This and other species of the order are figured in the Penny Cyc. ix. 390, and in the new edition of the Règne Animal.) *Encrinus radiatus* (*fig.* 57).

Pentacrinus europæus, Thompson, a minute animal found on the coast of Ireland, is now considered by this author to be the pedunculated young of Comatula, a starfish somewhat like *pl.* 76, *fig.* 62. This confirms one of the views of Agassiz (Lectures, p. 13), that the earlier fossil animals often resemble the embryonic or immature forms of the more recent periods.

Holopus rangii, Orbigny (*pl.* 76, *fig.* 56) (Mag. de Zool. 1837, *pl.* 3) is a recent genus from Martinique.

Order 2. Asteridea. In this order the supporting stem is wanting, and

the animal has the power of locomotion, sometimes by means of the arms, and sometimes with the aid of the sucker-like feet. The arms in some genera are provided with numerous lateral filaments, and in some cases they divide into branches. The genus *Astrophyton* (named also *Euryale* and *Gorgonocephalus*) (*pl.* 76, *fig.* 63), is remarkable for its five dichotomizing arms sending off branches, and terminating in a multitude of curled filaments, which, it is said, may amount to eight thousand in a single individual.

The genus *Ophiura* (*pl.* 76, *fig.* 64) is named from the resemblance which its long and slender arms bear to the tail of a serpent, not only in form, but in the numerous bony pieces of which they are composed, and which are not unlike the scales of a serpent. The arms are very flexible; and by giving them an undulating motion, the animal can swim to a certain degree. On each side of the base of the arms is an opening which is the outlet of the ovaries, of which there are ten. Several species inhabit the coast of the United States. In *Ophiolepis* (*fig.* 62), a genus allied to Ophiura, the disk is entire, with smooth plates. In both genera the arms have movable spines, which in some species are appressed, and in others projecting. The species figured, *O. scolopendrina*, is found near the Isle of France. In these genera the mouth is in the centre of the ventral surface, and from it are continued five grooves, through which a few sucker-like feet are projected. The mouth is armed with a strong osseous apparatus for masticating food. The arms, when broken off, can be reproduced. *Pl.* 76, *fig.* 61, represents *Astrogonium granulare* of the seas of northern Europe. In this genus the rays are not so well developed as in *Asterias* (*fig.* 60), which gives it a pentagonal figure.

Oreaster turritus (*pl.* 76, *fig.* 59) attains a length of ten inches, and inhabits the Indian Ocean.

Solaster is distinguished by an increased number of rays; *S. papposus* (*pl.* 76, *fig.* 66) is a foot in diameter.

Stellonia rubens (*fig.* 65) attains a foot in size, and is so abundant in the seas of Europe as to be spread over the soil as a manure.

Asterias (*fig.* 60) has the rays so much enlarged that there is room in the concavity of each for two extensions or appendages of the stomach, with an ovary between them, and a liver; which is not the case in the slender rayed genera like *Ophiurus*. Moreover, the size of the rays renders them less flexible, and badly fitted for locomotion; but as a compensation, they are pierced along their inferior surface (between short transverse bones arranged in series on each side of a deep central groove) with a multitude of ambulacral perforations, through which the feet already mentioned project, and which enable the animal to crawl up a surface as smooth as glass, and also assist in holding its prey. The sucker-like feet are connected within the aperture through which they project, with a globular vesicle filled with water, by the hydrostatic action of which the suckers are extended or withdrawn. Each vesicle is connected by a small tube with a canal which traverses each ray, starting from a circular canal around the œsophagus.

"This apparatus communicates with another tube which penetrates from the dorsal surface downwards, having its opening shut by a perforated plate called the madreporic body, which in starfishes is always seen in the angle between two of the rays; so that we have here an hydraulic apparatus of a very complicated nature." (Agassiz.) Through this series of vessels the water flows in both directions, either downwards through the upper aperture, or upwards through the tubular feet; subserving in its course the functions of locomotion and respiration. The water which fills the general cavity is admitted through the numerous minute perforations of the exterior. "The heart is placed along the calcareous tube which arises from the madreporic body, and the blood-vessels form circular rings around the entrance of the stomach, from which and to which the radiating arteries and veins move." (Agassiz's Lectures, and his Letter to Humboldt in 1847.) There are also movable spines upon the lower surface which assist in locomotion.

When food is taken, the animal bends its rays towards the mouth, so as to form a cup-shaped cavity, when the food is gradually moved to the mouth. There is no vent distinct from the mouth. The rays, when lost by accident, can be reproduced, and it is asserted that if a ray with part of the mouth be detached, it will form a new animal. The stomach is central and sends off two branching divisions or cæca in each ray. There is an English law which imposes a fine upon fishermen who do not kill a species of Asterias which is said to destroy oysters.

Agassiz has discovered that starfish, after their eggs are laid, take them up and retain them below the mouth between their suckers; and when they are forcibly removed to some distance, the animal will approach and take them up again, showing a remarkable instinct in so low an animal.

We pass from Asterias (*pl.* 76, *fig.* 60), through the pentagonal form Astrogonium (*fig.* 61) to Agassiz' genus Culcita, which resembles the last somewhat in shape, except that the five sides are convex instead of concave, so that the outline is more nearly circular, approximating the circular and oval forms of the next family.

Order 3. Echinidea. This order includes the oval or circular bodies known as sea-eggs, sea-urchins (*oursin* in French), the skeleton of which is a calcareous crust composed of twenty equal or unequal rows of polygonal plates pierced by various pores. The mouth is beneath, and armed or unarmed, central or sub-terminal; the vent is distinct, and varies in position, being formed beneath and above, and when beneath, marginal or towards the centre. The generative pores are four or five, placed around the summit.

When the animal dies, the integument (including the spines with which it is covered, and which present much variety in form and size) is soon lost, leaving the calcareous shell which protects the interior soft parts. The integument of the calcareous portion not only secretes the shell, but extends in a thin layer over the solid spines, which are thus formed layer by layer as the animal increases in size.

The circular form of these animals might at first induce an observer to doubt their affinity with the more star-shaped *Asteridea*, but if the rays of

the latter are supposed to be shortened, and the concavity between them filled up, the approximation will appear when the correspondence of the organs is considered.

The plates of an *Echinus* (*pl.* 76, *fig.* 69) run in vertical rows, two of which are wide and two narrow alternately; the wide pair have tubercles which support the larger spines; and the narrow ones have vertical rows of minute perforations which form the *ambulacra*, and allow the passage of the sucker-like feet which, in addition to the spines, are concerned in locomotion, and perhaps in passing water to the respiratory organs which lie beneath.

The mouth of the *Echini* is armed with five jaws working together by means of a complicated piece of mechanism, and which have been compared by Aristotle to a lantern, hence called the lantern of Aristotle.

Among the chief authorities upon this department are Lamarck, Blainville, Delle Chiaje, Goldfuss, Desmoulins, J. Müller, Sars, Milne Edwards, Dufossé, Duvernoy, Klein, Gray, and especially Agassiz.

The forms in this order are very various, from the flat and discoidal *Scutella*, which is flat beneath and but slightly convex above, to the subglobular *Echinus* and elevated *Galerites*, which is considerably higher than wide. Some have the ambulacra disposed in oval or elliptic lines upon the upper surface, resembling the four or five pètals of a spreading flower. According to Duvernoy, in the Echinidæ in which the rosette is formed, a series of branchiæ (instead of feet) are passed through these perforations, in addition to the internal branchiæ; and in consonance with this view, he divides the Echinidæ into two sections: the Exobranchia, with external branchiæ (including forms like Clypeaster, Cassidulus, and Spatangus); and the Homopoda for the remainder (including forms like Cidaris and Galerites).

Echinus, and other genera with large spines, are found on the bottom of the sea, whilst the *Scutellæ*, which have short bristly spines, burrow in sand.

Spatangus (*pl.* 76, *fig.* 67) and its allies have the mouth armed and placed towards the anterior end; the vent posterior, and placed upon the upper or lower surface; the shell thin in texture, lengthened, and gibbous; ovarian pores four.

Clypeaster (*fig.* 68), and the allied genera, have the mouth central, or nearly so, and the vent near the posterior margin, and upon the upper or lower surface, according to the genus.

Echinus (*pl.* 76, *fig.* 69), and *Cidaris* (*figs.* 70, 71), have a subglobular shell and two kinds of spines, the larger of which are supported upon large tubercles. The mouth is central beneath, and the vent in the apex.

The tendency to take an oblong form in *Spatangus* and *Ananchytes*, and the mouth being placed near the opposite extremities of the body, indicate an approach to the next order.

Order 4. Holothuridea. The animals composing this order have an elongated worm-like form, and the shell has disappeared, although some earthy matter is deposited around the mouth. In Holothuria and the allied genera the body is very contractile; the skin is irritable and has numerous mucous-secreting pores, and perforations for the passage of the sucker-like feet, which are either generally distributed, or arranged in five rows repre-

senting the ambulacra, or confined to the middle portion of the ventral surface. The mouth is fringed with branching tentacles capable of being withdrawn; the vent is at the opposite extremity of the body; and the entire animal bears a striking resemblance to a cucumber, whence it is called by sailors the *sea-cowcumber*, and one of the genera bears the name of *Cucumaria* (*C. frondosa*, *pl.* 76, *fig.* 85). They are extensively collected about the islands and reefs of the Eastern oceans as a culinary delicacy for the Chinese markets.

Captain Flinders mentions a Malay fleet of sixty vessels and one thousand men, as forming an expedition to fish for these animals.

"The object was a certain marine animal called *trepang;* of this they gave me two dried specimens, and it proved to be the *beche-de-mer* or sea-cucumber, which we had first seen on the reefs of the east coast, and had afterwards hauled on shore so plentifully with the seine, especially in Caledon Bay. They got the trepang by diving, in from three to eight fathoms water; and where it is abundant, a man will bring up eight or ten at a time. The animal is split down one side, boiled, and pressed with a weight of stones; then stretched open with slips of bamboo, dried in the sun, and afterwards in smoke, when it is fit to be put away in bags, but requires frequent exposure to the sun. A thousand trepangs make a *picol*, of about 125 Dutch pounds; and one hundred picols is a cargo for a prow."

ORDER 5. SIPUNCULIDEA. These are sometimes included in the order Holothuridea, with which they agree in the tentacles, the intestinal canal, and circulatory system, although they want the tubular feet. *Sipunculus* (*pl.* 74, *fig.* 7, and *pl.* 77, *figs.* 27, 28). According to Quatrefages the anatomy of *Echiurus* indicates an affinity both to the chætopodous annelida and to Holothuria, giving it characteristics of distinct types. Some authors, as Blainville and Gervais, place these animals among the Annelida.

CLASS HELMINTHES.

The classification of the various forms of worms has been attended with difficulties, some of which still remain, notwithstanding the efforts of distinguished naturalists to ascertain their characteristics. The worms, whose body is composed of a series of rings, as in the leech and earth-worm, and whose nervous system is composed of a line of ganglia, united by a double nervous cord, as in insects, form with these the division Articulata, of which they constitute the class Annelida.

After excluding the Annelida from the class of worms, there still remain many forms, both aquatic, and living in the interior of other animals, to which the term Helminthes is restricted. Here the annulate structure has disappeared, and the median nervous system has been separated into two distinct branches, usually arising from a large ganglion anteriorly, or two ganglia united by a transverse branch. From the characteristics which these animals afford, it is difficult to decide whether they belong to the radiate or articulate division of the animal scale, or, as is probable, form an

inter-class with characters common to both. Milne Edwards, Gervais, and Agassiz, think they form a common type with the Articulata, thus uniting all the worms in one division. The latter disposes of the differences in the nervous system, by considering them essentially the same, the two distinct or bilateral threads (and sets of ganglia, where they exist) being approximated to form a single series. The genus *Malacobdella* has certain intermediate characters, which render it difficult to place, the nerves being separated, the intestine simple, and the sexes separate. It is about an inch long, white, translucent like *Planaria*, and has a posterior sucker. It is marine, and lives as a parasite in the mantle of the molluscous genera *Mya* and *Venus*. Blanchard thinks it forms a distinct type of worms, as the generative organs alone have an affinity with those of the Annelida; and Duvernoy places it among the Trematoda.

On the other hand, the Helminthes may be regarded as a two-rayed animal (a view taken in part by Duvernoy), allied to the Radiata by this very nervous system, which, in *Tristoma* (R. An. *pl.* 36), forms a complete circle, which may be compared with that of the Radiata. The digestive system of this animal and of Planaria, bears an analogy to that of the Radiata, even the more typical forms, for in the Echinidea it has already departed from the radiated type. In some Planariæ (R. An. *pl.* 37, *fig.* 1^{c}) the gastro-vascular ramification forms a complete net-work, which has its counterpart in Rhizostoma (R. An. *pl.* 50).

We lay no stress upon the absence of the articulate structure in most Helminthes, because it is wanting in some of the Epizoa, which, although sometimes arranged with the Radiata, belong to the Crustacea. The articulate appearance of Tænia arises from the fact, that each joint is to a certain extent a single individual, affording an analogy with the Radiata, which is strengthened by the transverse nutrient tubes.

Cuvier, Duvernoy, and others, place the Helminthes among the Radiata. The classification of the latter, in 1848, is as follows, the vernacular names (which have no authority in science) being replaced by systematic ones.

Class Helminthes, comprising the three sub-classes, Helminthophyta, Parenchymata, and Cavitaria.

Sub-class I. Helminthophyta.

Animals simple or compound; form ribbon-shaped, a double alimentary canal, no vent. Including the two orders Cystica (from *Kystis*, a bladder) and Cestoidea (from *Kestos*, a band).

a. Cystica, with one family:

1. Hydatidæ.

b. Cestoidea, with three families:

1. Cysticercidæ.
2. Ligulidæ.
3. Tæniidæ.

Sub-class II. Parenchymata.

Form flattened, rarely cylindrical, nervous system bi-radiate; a bifurcated or branched alimentary sac. It includes the two orders and families:

1. Trematoda.
2. Planariidæ.

Sub-class III. Cavitaria.

Having a visceral cavity, the nervous system bi-radiated. Composed of four orders, the first having a visceral cavity instead of an intestine, the remaining three with two openings at the alimentary canal, at opposite extremities.

a. Enterodela,* with one family:

1. Acanthocephala.

b. Enterodela cylindrica [Nematoidea, *Rudolphi*], two families:

1. Ascaridæ.
2. Gordiidæ.

c. Enterodela plicata [Acanthotheca, *Diesing*], a single family and parasitic genus:

1. Linguatulidæ.

d. Enterodela tænioida, one family:

1. Nemertidæ.

The greater part of the Helminthes live in various parts of other animals, deprived of light, with little occasion for locomotive powers, and governed by circumstances of great uniformity, so that we need not be surprised at the simplicity of structure in individual genera, although they present a considerable amount of variation in the aggregate. From the mode of their occurrence within other animals, they have been termed *Entozoa*, in which certain external species are included. In some cases the same species is found in waters as well as in the interior of animals. There is scarcely an animal, whether terrestrial or aquatic, which does not nourish some of these parasites, and but few of the latter infest several distinct species. They have been found in beasts, birds, reptiles, fishes, insects, mollusca, and even in the acalephæ.

These entozoa are found, according to the species, in various parts of the bodies they infest, as the intestines, brain, bronchiæ, liver, kidneys, muscles, blood, and bones.

I. Helminthophyta.

a. Cystica.

These are named from the resemblance of the posterior part of the body to a bladder, a part which is filled with fluid (*pl.* 77, *fig.* 29). This is fibrous and sensitive, at times as large as an egg, and it sometimes forms part of several individuals. In Cœnurus the head or heads are each attached to a short neck; they are sub-globular, crowned with hooks, and have suckers arranged around the convexity, to enable it to attach itself to the substance whence it derives its nourishment. It lives in the brain and spinal nerve of sheep, and more rarely in the brain of oxen, destroying parts of it, and giving rise to a fatal disease, called by the expressive name of "staggers," from its chief symptom.

In *Echinococcus* (called *Acephalocyste* by the French) there is no head

* This name is inadmissible, having been previously used by Ehrenberg in the Infusoria, p. 24.

outside of the kyst, the animals being restricted to its inside. It occurs in the liver, spleen, and other parts, and is not exclusively confined to man.

b. Cestoidea.

Cysticercus is found in man as well as in animals, between the tissues of the muscles, sometimes penetrating to the eye-ball, the heart, and the brain. The form is that of the Cystica (with which it is usually and perhaps correctly placed), whilst in some other respects it approaches the Cestoidea.

What is called "measles" in hogs arises from an abundance of enkysted worms (*Cysticercus cellulosæ*, *pl.* 77, *fig.* 30), which have been found occupying as much space as the brain in these animals, and causing convulsions and death.

The intestinal worms of the genus Ligula (*L. cingulum*, *pl.* 77, *fig.* 34) are flat, ribbon-shaped, without articulations, marked with a longitudinal stria, and also transversely striate. They live in birds, and especially in fishes. The species figured is from one to five feet long, and is found in the *Cyprinus brama* of Europe. This worm is said to be eaten in some parts of Italy. *Bothrimonus sturionis* infests the American *Acipenser oxyrhynchus*. It is not articulated, it has a longitudinal impressed line above and below, with numerous raised points along it, those beneath having a pore. The head is sub-globular, with a double sucker.

The genus Bothriocephalus (named from *bothros*, a groove, and kephale, the head) is a long, flat, jointed worm, with a longitudinal groove upon each side of the sub-quadrate head, distinguishing it from *Tænia*, or the true tape-worm. It is also distinguished by having the segments much wider than long, and the openings from the ovaries are beneath, and not lateral. The genus infests birds, fishes, and reptiles; and one species, *B. latus* (*pl.* 77, *fig.* 32), infests man in Russia, Switzerland, and some other parts of Europe.

The common tape-worm, *Tænia solium* (*pl.* 77, *fig.* 33), is composed of flat, sub-quadrate articulations, which are very small and fragile for some distance from the head, so much so that this part is rarely obtained perfect, and the small head was for a long period unknown. The head is globular and provided with four terminal suckers, arranged in a square around the mouth. The alimentary canal is double, being composed of an intestine running along each side of the body, with a transverse canal connecting the opposite sides at the beginning of each segment, giving the interstices the appearance of a ladder. The centre of each segment is occupied by distinct generative organs of both sexes, which have their outlet in a lateral pore, alternately upon the right and left side of the segments. As each segment is capable of producing a large number of eggs, it is difficult to conceive why the animals should be comparatively so few in number. This species attains a length of twenty feet or more, and a single one is usually confined to a single individual, although as many as twenty have been found together. *Tænia cateniformis* (*fig.* 31) is about an inch long, and infests the cat.

II. Parenchymata.

These are soft contractile bodies, without any appearance of division

into rings, and bearing some resemblance to a leech, but sometimes so short as to be circular.

1. The *Trematoda* are internal monoicous parasites, having an anterior, suctorial opening, and one or more suctorial disks of attachment, which afford generic characters. *Distoma* (or *Fasciola*) *hepaticum* (*pl.* 77, *fig.* 36), which is a good example, is about an inch long, infests the gall-bladder, liver, and rarely the neighboring veins in man, sheep, oxen, deer, gazelles, camels, goats, horses, and hares. In sheep it is the cause of the fatal disease named rot. The severe winter of 1841–2 in Germany, was followed by the death of many deer, which were found to be much infested with Distoma.

Fresh-water snails of the genera Planorbis and Limnea are infested by a minute animal, with a globular body and slender tail, resembling a tadpole, and forming the supposed genus Cercaria, of which two American species were published in 1840, the motions of which are similar to those of their European analogues, the tail being rapidly thrown into the shape of an S, and easily detached.* Steenstrup has in some measure cleared up the history of the Cercariæ, which are the larvæ of Trematoda. After swimming about freely for some time, they attach themselves to the outside of the snail, and settle in the mucus of the exterior, maintaining themselves by an abdominal sucker, and in the course of their movements losing the tail, a loss which gives them somewhat the appearance of a Distoma. They now enter the pupa state, in which they remain for some months without apparent change. They afterwards acquire spines anteriorly, and such individuals were found within the snail. C. Th. Siebold thinks the Distoma is finally developed in the water-fowls which swallow the snails, an analogous fact having been observed by Creplin, who found a species in a stickleback fish, and also in water-fowls.

2. The *Planariidæ* contain a number of small leech-like animals, found both in fresh and salt water, which glide along like a snail over solid objects, or, passing up an object to the surface, they creep along this with the back downwards, and the belly attached to a thin film of water. The single opening to the ramifications of the stomach is usually about the centre of the inferior surface; and whatever is taken through this that is indigestible, is subsequently rejected by sucking in a quantity of water, and ejecting the whole together.

Planaria (*Planocera*) *cornuta* (*pl.* 77, *fig.* 35) has two horn-like extensions anteriorly. *P.* (*Dendrocœlum*) *gracilis*, Hald. 1840, is three fourths of an inch long, and one tenth broad, fuliginous, veined with black;

* *C. hyalocauda*, Hald. Body dark brown, or blackish, about as long as the tail; tail transparent, tapering, and suddenly diminished at its junction with the body. Just visible to the naked eye. Parasitic upon Physa heterostropha. Susquehanna.

C. bilineata. Perfectly white. Microscopic characters: Head and tail translucent; body with two dark longitudinal lines, which have a tendency to connect, so as to form a circle when the animal contracts; there is a light posterior circular spot occasionally visible, the tail is shorter than the extended body, and is not contracted at the base. Exceedingly numerous upon specimens of *Limnea catascopium*, collected at Camden on the Delaware.

oblong, suddenly tapering to a point posteriorly; sides nearly parallel; head truncate in front; neck narrowed, eye dots two, on the narrow part, oblong and white, with a black dot upon the internal margin; ventral opening less than one third the entire length from the posterior extremity. It inhabits springs in eastern Pennsylvania, and feeds upon animal matter. When cut in two, each part becomes an entire animal.

III. Cavitaria.

a. Enterodela.

1. The *Acanthocephala*, which are placed with the Parenchymata by Cuvier, are composed of round worms represented by the genus Echinorhynchus, the chief character of which is a straight, round, retractile trunk, armed with rows of recurved tooth-like hooks, which retain it in place when thrust into the intestines. A small pore is sometimes observable at the end of this trunk, but it is probable that nourishment is absorbed by its entire surface. A vascular tube runs longitudinally on each side, and is lost towards the posterior extremity. These noxious animals seem not to have been found in man, although numerous species infest vertebrate animals. They sometimes bore through the intestines, and pass into the cavity of the abdomen, and into other parts of the body. *Echinorhynchus gigas* (*pl.* 77, *fig.* 39) is from three to fifteen inches long, and infests hogs, especially such as are confined to be fattened.

b. Enterodela cylindrica.

1. The *Ascaridæ* include various genera of internal parasites, of which the genus Ascaris is among the best known, and contains slender, round worms, tapering towards both ends. The head is provided with three little valves, between which the mouth is placed. The intestine is straight, the vent terminal, and the nervous system bilateral. *Ascaris lumbricoides* (*pl.* 77, *fig.* 41) takes its trivial name from its general resemblance to a lumbricus, or earth-worm. It is white, from six to twelve or fifteen inches long, and the female is larger and more abundant than the male. It infests the small intestines of man, and is frequently fatal to children, in which it sometimes penetrates to the stomach, and even to the mouth. As many as five hundred have been ejected by a child in the course of eight days. It is sometimes discharged from abscesses in the abdomen, and it has rarely been passed from the bladder. This species infests the hog and the ox, and an allied one (once considered the same) is found in the horse.

Owen, some years ago, calculated the number of eggs in a female of this species to exceed sixty millions. Gluge and Mandl found eggs of an Ascaris, without the animal, in the lungs of frogs, supposed to be introduced with the air.

Oxyuris vermicularis, Linn. (*pl.* 77, *fig.* 42), is half an inch long, cylindrical, with the posterior portion subulate. It infests the large intestines of children.

Trichocephalus dispar (*fig.* 40) is found with the preceding species, and differs in having the anterior extremity attenuated like a thread, and resembling the lash of a whip, of which the posterior end would be the stock. It is one or two inches long, of which the thick part occupies about a third.

2. *Gordiidæ.* The genus Filaria is long, slender, thread-like, and smooth, with a somewhat rigid texture, and many species are found in various animals, including insects and mollusca. *Filaria medinensis* (*pl.* 77, *fig.* 43), the guinea worm, infests the muscles and subcutaneous tissues, chiefly of the lower limbs, in Arabia, Upper Egypt, West Africa, and the West Indies. It is sometimes located about the eye, and beneath the tongue; and occasionally it makes its way to the surface of the body, causing a sore, from which it may be extracted if a little is withdrawn daily, care being taken not to break it, as in that case the inclosed part remains and causes inflammation, which may render amputation necessary. A sailor, who frequently met Africans on shipboard with sores caused by the worm, had been on shore in West Africa for three hours barefoot, having himself a small sore on the thigh at the time. He arrived in England in October, 1843; and in the middle of the subsequent May a sore appeared on the left instep, which finally opened and disclosed part of a white worm, about the size of a violin string, of which five inches were cut off. This was succeeded by violent inflammation and suppuration upon the foot and leg, until the remaining two feet and a half of the worm came away. On the 23d of May another sore appeared upon the left fore-arm, disclosing a second filaria, which was gradually and carefully removed in fourteen days, and found to be thirty-two inches long. A third could then be felt under the integument of the right foot. This species attains a length of six feet, and is said to be sometimes seen swimming in the water of the countries it inhabits.

Filaria papillosa (*fig.* 45) is found in the abdomen, chest, and eyes of the horse. Dr. Charles A. Lee gives a figure of it in the *Am. J. Sci.*, 1840, vol. xxxiv. p. 279. He states that it is from one to seven inches long, and one third of a line in diameter. The specimen seen by him seems to have grown from half an inch to about four inches in four months.

Filaria phalangii (*pl.* 77, *fig.* 62) has been found in Phalangium cornutum.

Filaria lycosæ, Hald. Pale-reddish when recent; flavous when dried by heat; rigid, smooth, and shining, slightly tapering towards one end; about five inches long, and one millimetre in diameter at the largest end. Found in Eastern Pennsylvania, in a specimen apparently of *Lycosa scutulata*, Hentz, ten lines long, and, when the size of the spider is considered, a remarkably large species. The specimen being much contorted, and one end still within the spider, the precise length could not be determined. *Fig.* 43 might pass for a representation of it, and the spider is a little larger than *fig.* 37[a] in *pl.* 78.

The genus Gordius is found free in water, or as an internal parasite. *Gordius aquaticus* is found under all these circumstances, as it has been ascertained to infest insects. These worms resemble a thin thread or stout hair, and being seen in running water, or in puddles along roads, particularly after rain (see *Mag. Nat. Hist.*, 1836, pp. 9, 241–2, 355), they are popularly supposed to be metamorphosed horse-hairs. They are male and female, oviparous, and have a more complicated organization than their external simplicity might be supposed to indicate.

c. Enterodela plicata.

1. The *Linguatulidæ* are internal parasites infesting various organs; they are flattened and tapering posteriorly, and rugose transversely. In Linguatula the interior extremity is armed with a few recurved spines.

d. Enterodela tænioida.

1. *Nemertidæ.* The principal genus is *Nemertes*, Cuvier (*pl.* 74, *fig.* 10), an extremely long and soft marine worm, of a flattened form, the anterior extremity slender, and the posterior one ending with a broad attaching disk. It approaches Hirudo in its mouth and vascular system. It lives buried in the sand, and is said to feed on shell-fish.

Division II. Mollusca.

The Mollusca, or Malacozoa (soft animals), constitute one of the great *Divisions* of the animal kingdom. Except the shell, which is not always present, these animals have nothing in the nature of bones; and they want the ringed structure and jointed members of the Articulata. The body is soft, the integument slimy, and generally without epidermis, and in the testaceous species capable of secreting a shell. The alimentary canal has an opening at each end, and the circulating system is more or less complete. The eyes of univalve mollusca are generally situated upon or near the tentacles; those of bivalves upon the edge of the mantle, as in *Pecten* (*pl.* 76, *figs.* 27, 29); or on the posterior portion which forms the siphons, as in *Unio* (*pl.* 76, *fig.* 47).

From the great number, variety, and beauty of the shells of so large a portion of the Mollusca, the study of these, under the name of Conchology, attracted attention at an early period, when a cabinet of shells was often regarded in the same light as a casket of jewels, and great sums were paid for rare and handsome species; and, indeed, this interest still maintains its ground, there being shells, the price of which is one or two hundred dollars at the present day.

It was at length discovered that little of natural classification and the habits of this class could be known, without a study of the entire animal; so that Conchology finally became merged into Malacology. There is, however, no impropriety in the use of the former term in an enlarged sense, if it be considered to include the study of those animals which are usually provided with a calcareous shell.

Some of the older conchologists, guided by the shell alone, included radiated forms, like Echinus, in this division; and even at the present day, the *cirrhopoda* (*pl.* 76, *figs.* 51–54) and some of the annelida, which have a hard exterior tube, are sometimes described in books avowedly devoted to mollusca. On the other hand, whilst all "shells," whether secreted by the mollusca or the articulata, were classed together, true mollusca, when unprovided with a shell, were often placed among worms and annelida.

The term (Vermes) Mollusca was used by Linnæus in 1758, in a wide

sense, as it included radiata, like Actinia, Medusa, and Echinus; crustacea like Lernæa, as well as Ascidia, Limax, and the Cephalopoda, and even some annelida; whilst his order (Vermes) Testacea included most of the univalve and bivalve shell-fish. The "class Mollusca" of Lamarck, follows his class Conchifera, and includes the five "orders," as he terms them, of Pteropoda, Gastropoda (excluding the spiral univalves), Trachelipoda (including the spiral univalves), Cephalopoda, and Heteropoda. Pallas and Cuvier were the first to use the term Mollusca in its modern sense; and the latter, in 1798, recognised three sections, subsequently provided with the systematic names of Cephalopoda, Gastropoda, and Acephala. The term Mollusca having by these means acquired a somewhat indefinite meaning, Blainville proposed that of Malacozoa, which is the preferable term, if the term Malacology supersedes that of Conchology.

The shell of the Malacozoa can have one, two, or more pieces; it may be external or internal, and it varies much in size, being in some cases capable of containing all the soft parts, with room to spare, and in others a mere excrescence upon some part of the animal. It is secreted by the mantle, a fold of the integument which appears as a flap, lining the shell in bivalves, and a continuation of it appears as a collar around the neck, and lining the aperture of the shell in the spiral univalves. In the order Tunicata the body is inclosed in a kind of coriaceous purse instead of a shell.

The mantle usually secretes two kinds of material, the nacre, or pearly portion of the shell, and the epidermis, or *periostraca;* but in some genera the latter is absent, as in *Oliva* (*pl.* 75, *figs.* 122, 125, 126) and *Cypræa* (*pl.* 76, *figs.* 5–7), in which the wide mantle is turned up on each side, so as to inclose the shell. When the shell is broken by accident, the crevice is closed by layers of nacre; and if a pebble gets into the shell by accident, and cannot be got rid of, it is covered in like manner. When the nacre or "mother-of-pearl" is of a fine quality, the tubercular masses which arise from injuries have a peculiar lustre, which causes them to be admired under the name of pearls. Shells are often found repaired, which had been crushed and distorted to such an extent as to lead one to believe it scarcely possible for an animal to survive after so much mutilation.

The varied spots and lines which ornament so many marine shells, are distributed by the periodical action and inaction of the secreting process. The species of the genus Conus, although covered by a thick epidermis, are usually marked with bands, spots, and reticulations of brilliant colors, which make them a favorite ornament to collections. The epidermis, however, should not be removed, or it should at least be preserved upon a specimen of each species, as it varies considerably according to the species. The former unscientific custom of polishing such shells as have a homely exterior is now discontinued.

The microscopic structure of shells presents many curious features, which have been thoroughly studied by Carpenter, who has illustrated the subject with figures. In some shells the structure resembles that of minerals, and seems to be formed of minute crystals of carbonate of lime, or of fibres resembling arragonite.

In the genus Argonauta (*pl.* 76, *fig.* 17) the ends of two of the arms are greatly dilated, and these dilations clasp the shell upon each side, which seems to be formed by a secretion from their inner surface.

In some of the naked land-snails, like *pl.* 77, *fig.* 21, a small thin shell may be taken out of the back, and the cuttle-fish has a corresponding internal shell, known as cuttle-bone, which is more complex, having a hard, rough surface above, and a series of close-set, thin, parallel plates beneath. The lower end terminates in a point which corresponds to those fossil organic remains of cephalopoda, named Belemnites.

In bivalve shells the mantle is slightly attached to the shell, in some degree parallel with its margin, and at a little distance from it; but this line of attachment, which is named the *pallial impression*, varies considerably in its course in different families, and through this variation affords distinctive characters. The mantle, or projections from it, secretes the spines, rugosities, and other appendages, by which the shell is varied. Sometimes the deposition of the shell goes on smoothly, when a thickening of the margin, a varix, or a row of spines will be secreted, to be followed by a smooth space, and this alternation takes place as long as the animal grows. See *pl.* 75, *figs.* 101–104, 111, 119. Univalve shells are usually strengthened by having the margin of the aperture thickened, and as this is added from time to time, the shell may acquire a ribbed appearance, as in *figs.* 101, 102. In other cases, as in *fig.* 91, the old lip is absorbed before a new growth is started, so that the shell remains smooth. Sometimes the margin is not formed until the animal attains its full growth.

The oblique deposition of calcareous matter in spiral univalves gives them an elongated form, as in *pl.* 75, *fig.* 117, and when less oblique, the shell is more robust (*fig.* 98). In forms like *Patella* (*fig.* 77) the calcareous deposit extends in equal degrees; but if the increase is more abundant upon one side, the spine is curved, as in *fig.* 81. When the aperture is lateral, and the shell has little or no obliquity, the forms seen in *pl.* 76, *figs.* 2, 4, 7, 11, are the result.

In spirivalve shells the solid axis is named the columella, and a muscle is attached to it which connects the animal with the shell, and enables it to retire within it. The columella is often marked with prominent folds and tooth-like projections, which afford generic characters. The anterior extremity of the mantle is elongated in some genera, and the edges brought in contact, so as to form a slender tube, through which water passes to the gills; and as this siphon secretes calcareous matter, the shell takes the *rostrated* form, as in *pl.* 75, *figs.* 109–112.

Spiral shells are usually *dextral*, increasing towards the right, in which they resemble an ordinary screw; but there are a few genera, exceptional species, and varieties of dextral species, which are sinistral (*pl.* 75, *fig.* 100). A bivalve shell is considered sinistral when the projecting points at the hinge, named teeth (which present a certain degree of uniformity in each species), are changed so that the modification which belongs to the one side normally is found upon the other.

Some of the spirivalves, when the animal retires into the shell, as in *fig.*

88, close the aperture by an *operculum* attached to the posterior and upper part of the foot. It is sometimes smaller than the aperture, and can be drawn in some distance; in other cases it fits the aperture exactly. In texture it is either thin and horny, or thick and shelly, sometimes increasing obliquely or spirally, by deposition upon one side, and at other times enlarging concentrically, but always taking the shape of the aperture. In the genus Hipponyx the anomaly is presented of the operculum being attached to the rocks upon which the animal is found. In dry seasons the land-snails protect themselves by a temporary operculum, formed by a slimy secretion, which hardens, and thus closes the aperture.

Most bivalves, as the name implies, are composed of two valves (*pl.* 76, *figs.* 32–34), united by a ligament upon the back; but some of these have accessory pieces (*fig.* 49), which are not of sufficient importance to remove them from their class. Even the anomalous form, *Aspergillum* (*pl.* 75, *fig.* 71), belongs to the Bivalves or Conchifera; for, although it is a shelly tube, pierced at the anterior extremity like a pepper-box, an examination will disclose a small open bivalve shell, solidly imbedded in the shelly material of the tube. This is roughly represented near the upper end of the figure, although the artist probably did not recognise its true character.

The nervous system of the Malacozoa is not symmetrical, as in the Articulata, nor radiated, as in the Radiata, but the ganglia are distributed unsymmetrically from the brain, or chief ganglion, situated above the œsophagus.

The Malacozoa are divisible into three sub-divisions or classes, the lowest containing the *Acephala* (*pl.* 76, *fig.* 34, &c.), named Acephalophora by Blainville; the next the *Gastropoda* (*fig.* 1, &c.), named Paracephalophora by Blainville, and including the Pteropoda, according to this author; and the highest the *Cephalopoda* (*pl.* 76, *figs.* 16, 17, 75–77).

Class 1. *Acephala.*

This class contains the four orders Bryozoa, Tunicata, Brachiopoda, and Conchifera. The sections, here named *orders*, are by some naturalists considered to be classes, which they sub-divide into orders of a different value. Indeed, it is extremely difficult to construct groups which shall have the same value under the same name, in different departments of Zoology; and there is no special rule which can be followed in all cases.

Milne Edwards, observing that the Bryozoa, which had previously been confounded with the Zoophyta, bear certain near relations to the Tunicata, united the two in a sub-division of the true mollusca, and Cuvier had previously shown that the Tunicata are related to the Conchifera. Dujardin gives to the group of Bryozoa the same value among the Mollusca that he assigns to the Conchifera and Brachiopoda. Agassiz also unites them to the Acephala, of which he considers them to be the lowest order, corresponding to the Foraminifera, to which he assigns the lowest place among the Gastropoda. In fact, the Bryozoa have much resemblance to the Mollusca in their alimentary canal, which is quite different from that of the Zoophyta.

Order 1. Bryozoa. This name was imposed by Ehrenberg, who was one of the first to demonstrate the true nature of them. They are small animals, aggregated in great numbers, like coralligenous zoophytes, having a distinct stomach and an intestine curved upon itself, with an outlet near the mouth. An analogy with the Cephalopoda is apparent in the tentacles which surround the mouth, and which are covered with vibrillæ. These vibrillæ cause currents of water which bring the animalcula within reach, which serve as food. The tube into which the animal withdraws varies in texture, being membranous, horny, fibro-gelatinous, or calcareous. This tube corresponds to the outer tunic of the Tunicata, in being in organic connexion with the interior parts, even the calcareous matter of the harder kinds being deposited throughout the membranous tissues. Each tube is in contact with its neighbors, sometimes to the number of many thousands.

Dr. Farre thus describes the tube or cell in the Vesicularidæ: "The transparent horny cell which closely embraces the body of the animal, is nearly unyielding in its lower two thirds, but terminates above by a flexible portion, which serves to protect the upper part of the body when the whole is expanded, in which state it is of the same diameter as the rest of the cell, but, when the animal retracts, is folded up, and drawn in after it, and completely closes the mouth of the cell. The flexible part consists of two portions, the lower half being a simple continuation of the rest of the cell, the upper consisting of a row of delicate bristle-shaped processes or setæ, which are arranged parallel with each other around the top of the cell, and are prevented separating beyond a certain distance by a membrane of excessive tenuity, which surrounds and connects the whole. This mode of termination of the cell is one of constant occurrence, as will be described in other species, and is evidently a provision for allowing of the freest possible motion of the upper part of the body in its expanded state, to which it affords at the same time support and protection."—*Phil. Trans.*, 1837, p. 393.

Johnston thus describes the habits of some of these animals: "Let us now suppose that the polypes are in a state of extrusion, and fully expanded, all the cilia in play, and the water whirling in rapid streams up and down the opposite sides of the tentacula, carrying with them nutriment and the breath of life. All is quietness and security around, and the little creatures are evidently in a state of happiness and enjoyment; no one who has witnessed the microscope scene (the myriads of the little flosculous heads that pullulate and blossom over the entire polypidom, as thickly peopled as the swarming hive) can have any doubt of this, especially when he remarks the acuteness and vivacities of their sensibilities and actions; for, under his eye, one will ever and anon suddenly sink out of view, hide itself within the cell, again on a sudden emerge and expand, or, it may be, lay itself down in repose and concealment, until digestion has freed it from a state of repletion, or forgetfulness has removed the alarm of an enemy. These positions are assumed with such rapidity, that the eye cannot trace the steps of the process, and large glasses and minute skill are required to reveal to us its mechanism."—*Brit. Zooph.*, p. 241.

Excellent figures of this group are given by Milne Edwards, in the illustrated edition of the Règne Animal, and by Johnston. The following genera of Escharidæ are figured on *pl.* 75: *Flustra* (*fig.* 54), *Retepora* (*fig.* 56), and *Eschara* (*fig.* 57). The following classification is that of Johnston:

*Natives of the Sea. Tentacula forming a perfect circle. *Polypiaria infundibulati*, P. Gervais. *Fams.* 1 to 6.

**Lacustrine. Tentacula in the form of a horse-shoe. *Polypiaria hippocrepia*, P. Gervais. *Fam.* 7.

Fam. 1. *Vesicularidæ.* Corneous, fistular, confervoid; cells vesicular, deciduous, not operculate. Vesicularia, Serialaria, Valkeria, Baverbancia.

Fam. 2. *Crisiadæ.* Calcareous, branched, confervoid, jointed; cells linked together in series, distinct, tubular, or elliptical, with a terminal or subterminal aperture; no operculum. Crisia, Notamia, Hippothoa, Anguinaria.

Fam. 3. *Tubuliporidæ.* Calcareous, variable in shape, never confervoid; cells tubular, round, rising from a base and projecting, aperture terminal and non-operculate. Tubulipora, Discopora.

Fam. 4. *Celleporidæ.* Calcareous, lobed, ramous, or crustaceous; cells in quincunx, utricular, in juxta-position, with a contracted terminal aperture. Cellepora, Lepralia, Membranipora.

Fam. 5. *Escharidæ.* Calcareous or membranous, variable; cells usually in quincunx, oblong, pentagonal, or hexagonal, conjunct, immersed, or horizontal to the plane of axis, with a subterminal or lateral, and commonly operculate aperture. Flustra, Cellularia, Acamarchis, Farcimia, Retepora, Eschara.

Fam. 6. *Alcyonidulæ.* Polypidoms sponge-like, polymorphous; cells irregular in disposition, immersed and concealed, with a contractile non-operculate aperture. Alcyonidium, Cliona.

Fam. 7. *Limniades.* Polypidoms fleshy, spongy or corneous, polymorphous; animals in tubes with angular or round orifices, closed when they recede. Cristatella, Plumatella.

Order 2. Tunicata. These animals, especially *Ascidia* (*pl.* 77, *figs.* 7, 8) and its allied forms, may be compared to bivalve mollusca or conchifera, in which the margins of the mantle are united so as to form a sac, in which two openings are left, one for alimentation and respiration, and the other for excretion. The mantle is of a tough coriaceous or cartilaginous texture, and is endowed with contractility. Cellulose, which is almost exclusively found in plants, has been ascertained to enter into the composition of the Tunicata. A current is made to flow over the branchiæ by the action of the vibrillæ, and the contractions and expansions of the body remove the water.

The Tunicata have no external organs of locomotion, so that they float about at random, or are fixed to rocks, sea-weed, or other extraneous bodies. Some species are agglutinated together in masses, or in long chains, but there is no organic connexion between them.

This order includes three families represented by the genera Salpa,

Ascidia, and Pyrosoma. *Salpa* (*pl.* 77, *fig.* 3) forms long lines of aggregated individuals. These animals were first distinctly noticed in 1756, and named Thalia in Brown's History of Jamaica, and in 1775 Forskal applied the name of Salpa. The mantle is transparent, and is provided with tubercular suckers, by means of which the bodies adhere together. The aggregated individuals produce young which are free, and which are unlike the parent; and these free individuals produce a brood of aggregated individuals, thus presenting an example of alternate generation. This discovery was published by Chamisso in 1830. These animals abound in the warm seas, swimming at various depths, commonly with the back downwards, and coming to the surface in calm weather. Their power of locomotion is slight, the only means being the ejection of water which has been used in respiration. (See Agassiz's *Lect. Embryol.*, p. 91.) Pyrosoma includes compound, gelatinous, and nearly transparent animals, remarkable for their brilliant phosphorescence.

Order 3. Brachiopoda. "The Brachiopoda ought to be combined with Lamellibranchia, having the same structure, and differing only in secondary modifications." (Agassiz.) This order includes bivalve mollusca, named from having a long, spiral, fleshy, arm-like, fringed organ on each side of the mouth, used in securing food, and generally capable of being extended and withdrawn into the shell, and when large it is rolled into a spiral. In the genus Spirifer, which is scarcely more than a Productus, these organs are preserved in a mineralized state. The mouth is provided with fleshy lips, and is situated between the arms. The mantle itself subserves the purposes of respiration, a peculiarity which is recorded in the name Palliobranchiata, given to them by Blainville.

The shell is often adhering, either directly, as in *Crania* (*pl.* 76, *fig.* 24), or by means of muscles, as in *Terebratula* (*fig.* 23), in which the muscles pass through a perforation in the beak of the left valve. This genus has a curious framework within the shell. The species figured, *T. caput-serpentis*, Linn., and *T. psittacea*, Gmelin, are found upon both sides of the North Atlantic. (See Gould, *Invertebrata of Massachusetts*, pp. 141, 142.)

It has been maintained that in this order, the valves, instead of being right and left, are dorsal and ventral, the large or perforated one being dorsal. Professor Agassiz (*Moules de Mollusques*, p. 14) thinks this view is founded upon a false interpretation of the anatomy, and that the Brachiopoda do not present this anomaly. He considers the larger valve as that of the left side, as in Ostrea and Anomia, but whilst the left valve is perforated in Terebratyla, Anomia has the perforation in the right. The descriptions of some conchologists being founded upon the opinion that there is an absence of orientation in the valves of this order, must be read with care or they will not be understood.

In the genus Lingula the two valves are so much alike that it is difficult to decide upon their mutual relations. In this genus there is a long pedicle, but probably not for attachment to extraneous bodies, as the species live buried in the sand.

Order 4. Conchifera. This order contains most of the bivalve shells,

including some with accessory pieces. From the laminated form of the gills, two of which usually hang like a curtain on each side, between the mantle and the body, they are named Lamellibranchia by Blainville.

In the Conchifera the back of the animal is under the hinge of the shell; and when the shell is removed, the heart may be observed in some families beating at the anterior part of the back. Beneath this, at the anterior extremity, is a simple opening constituting the appendages named *labial palpi*, the vibrillæ of which cause currents, which bring nourishment within reach.

Upon comparing the shell of an oyster with that of a freshwater mussel, a discolored impression will be found near the centre of the former, and two impressions in the latter, situated towards each end. These are the *muscular impressions*, serving for the attachment of the *adductor muscles*, which draw the valves together; and when they are relaxed the shell is opened by the elasticity of the dorsal *ligament*, which may be either external or internal.

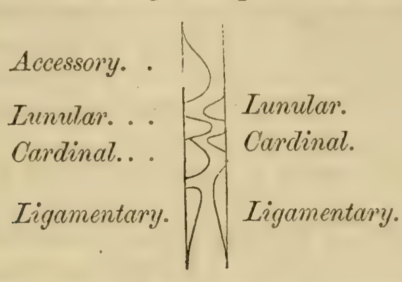
Some conchifera remain permanently fixed, like the oyster, which is attached by its left valve. Others, as *Pinna* (*pl.* 76, *fig.* 18), are attached by a bunch of fibres, named the *byssus*, which is secreted by the foot. Some can swim by alternately opening and closing the valves, of which *Pecten* (*figs.* 27–9) affords an example; whilst others move by means of a foot, which enables them to burrow in the mud, or move along in the sand. The foot is situated below the mouth; and when present, the mantle must be open to allow it to pass. See *pl.* 76, *fig.* 50, left-hand end.

Posteriorly the mantle has two openings, one above the other, forming *siphons* for respiration and excretion. These are sometimes made merely by the partial contact of the ends of the mantle, which may project but little, although at other times it extends and forms long perfect tubes (*fig.* 50). The inferior tube is named the *branchial siphon*, and is used in breathing; the upper one is the *anal siphon*, and serves for the excretions. The curve in the pallial impression is caused by the displacement of the mantle, to afford room for the retracted siphons when their size is considerable.

The hinge is usually provided with projections of calcareous matter, named teeth from their shape; and those of one valve are fitted into corresponding vacancies or depressions in the other. These present so many modifications that they have been made a principal character in the construction of genera. Those situated under the beak of the shell are termed *cardinal* teeth; and those *anterior* and *posterior* to these the *lateral* teeth, a badly selected term, all the teeth being equally lateral. Indeed, the hump of a dromedary, or the dorsal fin of a fish, might as well be termed "lateral." This misapplication arose when the length of a bivalve mollusc from the mouth towards the vent was named its breadth, and Lamarck, Say, and others, named that end "posterior" at which the mouth is situated, and which precedes in locomotion. A few minutes devoted to observation and dissection of the animal would have prevented this error, which must be borne in mind in reading the descriptions of these authors, or they cannot

be understood. In some genera, as *Arca* (*pl.* 76, *fig.* 32), the teeth are alike, and form a crenulated line along the dorsal margin of the shell.

In the seventh volume of the Nouv. Mém. de la Soc. Helvét. des Sc. Nat., Professor Agassiz has proposed an improved nomenclature for the armature of the hinge in Venus and the allied forms, but which may be extended to other families. The annexed diagram represents the relative positions and



names of the teeth, the upper part representing the anterior part of the shell, its back being towards the observer, and the right valve upon the right hand. The presence of the accessory tooth in the left valve distinguishes the genus Cytherea from Venus. The same name is applied to a tooth and its corresponding cavity in the opposite valve.

Most of the Conchifera are marine, living attached, half buried, or entirely buried in the sand or mud, some at the bottom of a perforation from a few inches to several feet deep. Others perforate wood, and some rocks; and as they increase in size, enlarge the prison which they are never to quit, receiving their nourishment through the opening by which they entered.

The Conchifera may be divided into several tribes, named *Rudista*, *Inclusa*, and *Elatobranchia*. The first of these, Rudista, is doubtful as a separate section, being composed of bivalve shells, the lower one of which is adherent, and the upper raised in a conical form; but their true nature and position in the animal scale have not been determined, and they occur only in a fossil state. Some authors place them near Chama in the Elatobranchia; others think them Brachiopoda, and even Tunicata; and others elevate them to the rank of a distinct order. Some of these bivalves were at one time believed to present the chambered structure of Orthoceras, and they have on this account been incorrectly referred to the Cephalopoda by some authors. This was the case with *Hippurites*, one of the principal genera, which was placed near Belemnites. In Hippurites there is, indeed, an imitation of a chambered structure, but it has an analogy to that observed in certain species of Ostrea, when the shell is sawed in two across the foliated layers, the siphon of the Cephalopoda having no existence.

Tribe Inclusa.

The members of this tribe, although inclosed in bivalve shells, resemble the Tunicata in having the margins of the mantle closed for about three fourths of its circumference. The more typical forms have the shell gaping, and a long double siphon posteriorly, which cannot be entirely withdrawn.

Fam. 1. *Mactridæ.* Hinge with an erect V-shaped tooth, ligament internal. The genus *Mactra*, Linn. (*pl.* 76, *fig.* 40), includes sub-trigonal shells which are slightly gaping; hinge with a concave tooth to receive the ligament; two additional striated teeth near the hinge. This genus contains shells which sometimes attain a considerable size. *M. solidissima*, Chemnitz (Gould, *Invertebrata of Massachusetts*, p. 51), of the United States coast, is sometimes found six inches long and four in height. In this family the foot passes through an opening in the mantle, and the two siphons, although distinct, are inclosed in a common integument. Some authors place this family among the Elatobranchia. *Lutraria lineata*, Say, American Conchology (*pl.* 9). *L. plicatella*, Lamarck, vol. vi. p. 93.

Fam. 2. *Myidæ.* This family is differently divided by different authors, some including the two groups of which *Osteodesma* and *Solemya* are the types, whilst others believe that these should form distinct families. In Mya the shell is gaping, and there is a broad spoon-shaped tooth projecting from the hinge to the opposite valve, where there is a cavity to receive it. The labial palpi are long, stout, and pointed. The mantle is closed, except a small anterior opening for the passage of a slender foot, and the ordinary openings for the siphons, which are very long, and inclosed in a common envelope. This genus buries itself in the sand, with the exception of the end of the siphons. *Mya arenaria*, which has a shell three or four inches long, inhabits both sides of the Atlantic, between high and low water-mark. It is extensively used in New England as food, under the name of *clam*, a name which is applied to Venus mercenaria in the middle States. The genus Corbula forms part of the restricted family of Myadæ.

In the opinion of some authors, Osteodesma and the allied genera Lyonsia, Periploma, Thracia, and Anatina, form a family, although the aggregate of these genera seems to have no higher rank than that of a sub-family. Some of the shells are of an extremely delicate texture; these have no cardinal teeth, and there is an ossiculum or accessory bone forming part of the mechanism of the hinge, upon which Deshayes has founded the family name *Osteodesmacea.* *Mya norvegica* was at first the type both of *Lyonsia*, Turton, 1822, and *Osteodesma*, Deshayes, 1835, but the latter author subsequently admitted Lyonsia, and applied his own term to a different group. Couthouy's paper in the third volume of the Boston Journal of Natural History, and Gould's Invertebrata of Massachusetts, may be consulted upon these genera.

Fam. 3. *Solemyidæ.* The genus Solemya is by some considered as forming a distinct family, whilst by others it is placed in the family of the Solenidæ. Some of its characters are very distinct; the branchiæ are thick, and single upon each side, and they are divided so as to resemble those of Crustacea. The foot is truncated and shaped like a sucking disk; the posterior half of the mantle is closed, the siphons are short, and the periostraca of the shell projects in a flap, far beyond the calcareous portion.

Fam. 4. *Saxicavidæ.* This family includes Saxicava and Byssomia. The first contains small species and secretes a byssus. The cardinal teeth

are obsolete, the ligament is external, and the shell gaping. The shell presents many distorted varieties, and some species excavate cavities in rocks. Some authors unite this family to the Lithophaga, among the Elatobranchia.

Fam. 5. *Pandoridæ.* A small family formed of the single genus Pandora, which has only a single branchia on each side. The shells are small, pearly within, the valves unequal, the ligament interior, the siphons short, the hinge with two diverging teeth in the right or flat valve, and two corresponding impressions in the left, which is convex. *P. trilineata*, Say (*American Conchology*, *pl.* 2), inhabits the American coast from Maine to Florida. This genus is by some placed with the Solenidæ, and by others with the Myidæ.

Fam. 6. *Solenidæ.* This family is composed of the genera Solen (*pl.* 76, *figs.* 45–6), Solecurtus, Glycimeris, Panopæa, and Pholadomya. The ligament is external, the shell gaping at both ends, and the foot is long and fleshy, and is passed out of the anterior extremity. The genus Solen lives in holes several feet deep, in which it passes up and down by means of its foot, and with such rapidity that it is difficult to take. Fishermen take them for bait by suddenly thrusting a barbed spear into their retreat, but if they are not struck at once they descend beyond reach. The genus Glycimeris is remarkable for having the body so large in proportion to the shell, that the latter is unable to inclose it. G. siliqua, the only species of the genus, as now restricted, inhabits the banks of Newfoundland, and the shell is usually got from the stomachs of cod-fish. Panopæa is a genus including species mostly of a large size, few in number, and occurring recent and fossil. P. arctica inhabits the banks of Newfoundland, and about eight fossil species have been named from the tertiary formations of the United States.

Fam. 7. *Pholadidæ.* This family contains various genera, which live in perforations which they make in rocks, wood, or clay, each being a prisoner for life in a cell of its own construction. In *Pholas* (*pl.* 76, *figs.* 49, 50) the shell is widely gaping, and provided with accessory pieces at the hinge (*fig.* 49), and the foot is shaped like a sucker. *Pholas dactylus* (*fig.* 50) is used as food. A few fossil species are found in the tertiary formations of Europe and America. The genus Teredo is placed by some authors in the next family, *Tubicola*, on account of its form; but Deshayes thinks the characters of the animal require that it should be placed here. *Teredo navalis* (*pl.* 75, *fig.* 67), which is so destructive to timber and shipping when not protected, appears as a long, sinuous, calcareous tube, lining perforations in wood, and if one of these be followed to its lower end, the valves of the shell will be found. The shell is thick, and so short as to be annular, having a single adductor muscle, and the posterior extremity of the tube is open. According to Laurent, when the young Teredo escapes from the egg, it swims about by means of vibrillæ. At first the body is inclosed in the shell proper, and the little animal can move about with the aid of a long linguiform foot. After spending about twenty-four hours in swimming and moving about upon submarine objects, it attaches itself to wood, making a depression in which it locates itself, and excretes a mucous mass which covers it, but allowing a passage for the siphons. The young animal

is soon after able to commence perforating. The transparent shell of the embryo soon disappears, and is replaced by the permanent one. In boring, the wood is generally entered across the grain, but afterwards the animals turn in the direction of the fibres, though they are subject to be continually turned from their course by each other, the wood being perfectly honey-combed by their number, and often in the course of a year.

Fam. 8. *Tubicola.* The name indicates the tubular form of the external protection in this family. The tube is secreted by the mantle, and its continuation covering the siphons. In *Aspergillum* (*pl.* 75, *fig.* 71) both valves form part of the tube; in *Clavagella* the valves are placed within a short tube, one of them being attached; and in *Gastrochæna* the shell is not attached, but inclosed in a tube. The mantle is open in front for the passage of a little foot, the siphon and branchiæ are usually long, and the palpi are small. These shell-fish inhabit clay, sand, or cavities in stone or wood, pierced by themselves.

The genus Aspergillum was first correctly figured in 1685, by Lister, one of the fathers of conchology; but it was many years before its true approximate place was known, since it required much sagacity to detect a bivalve shell under the form of a tube. We accordingly find it placed at one time among univalve genera, and at another with the Annelida which form tubes, and Linnæus placed it with Dentalium. The happy idea of Aspergillum being a true bivalve is due to De Roissy, and is a remarkable example of the detection of natural affinities. A parallel example appears in the *Planorbis cornuarietis* which, to all appearance, was referred to its proper genus, but which Sowerby referred to Ampullaria, with none of which did it seem to be allied; but the subsequent discovery of the animal proved his reasoning to be correct, although strongly opposed at the time. The structure of Clavagella is quite anomalous, the valve of the right side forming part of the inside of the tube, and the left valve being free. The anatomy is essentially that of a bivalve mollusc, and shows an affinity with Aspergillum. It is provided with a small foot.

The genus *Gastrochæna*, Spengler, 1783 (or *Fistulana*, Lam., 1801), is a boring shell, sometimes found in calcareous rocks, and sometimes in sand, secreting, besides its proper shell, a separate exterior tube; and, as the shell may be accidentally found without the tube, after the death of the animal, an error was committed in describing the shell alone as one genus, and the tube and shell together as another, namely, Fistulana; an error which Deshayes was the first to correct, and he accordingly suppresses the latter name. Shell symmetrical, and widely gaping anteriorly, without cardinal teeth, a ligament posteriorly, pallial impression deeply sinuated, foot small, and secreting a byssus. The following species are found in the tertiary strata of the United States. *Gastrochæna ligula*, H. C. Lea, *Am. Phil. Trans.*, vol. ix. *G. larva*, Conrad (*Fistulana*), *Am. J. Sci.*, 1846, p. 213. *G. elongata*, Desh., Conrad, *Nat. Inst. Washington.*

Tribe Elatobranchia.

This tribe includes the great mass of Conchifera, after separating the preceding one. With very few exceptions, the Inclusa have two adductor

muscles, and although the same character is possessed by most of the Elatobranchia, a large portion of them have but one, so that the whole are divided by this character into two sections, thus:

§ *Monomyaria*, with one adductor muscle.

§§ *Dimyaria*, with two adductor muscles.

This character, although of much importance, is not applicable in every case, because a classification that would adhere to it strictly, would sometimes unite dissimilar groups and separate allied ones, as far as the other characters are concerned. The first section includes the five families: 1. Anomiidæ; 2. Placunidæ; 3. Ostreidæ; 4. Pectinidæ; 5. Aviculidæ.

Fam. 1. *Anomiidæ.* The genus Anomia has a principal central adductor muscle, but besides this it has two approximate, one passing towards the perforation at the apex of the smaller (and in position the lower) valve, where it is attached to a shelly plug, shaped like a short, flat-headed rivet, and inserted in the aperture, its exterior flattened surface being attached to extraneous bodies. The ovary terminates between the membranes of the mantle upon the right side, where the eggs are stored before they are ejected, an anomaly presented by no other conchifer, but which, with some other characters, indicates an affinity with Brachiopoda. On this account Deshayes thinks that this family forms a distinct group, which should stand between the Brachiopoda and the Conchifera. In Anomia the margins of the mantle are entirely disunited; the shell is very irregular, orbicular, the free or larger valve convex, and the lower one concave or flat, and taking the form of extraneous bodies, to which it is attached. This causes the shell to offer many varieties, and the species to be of difficult determination. The aperture in the perforated valve is only a deep sinus, narrowed at the margin, with the shell projecting upon one side, and forming an ossiculum with a flattened surface of articulation, which enters and is attached to the concavity of the opposite valve by an internal ligament. This family is allied to the next by Broderip's genus, Placunanomia, which has a notch in the side of the lower valve, presenting an analogy with that in Pedum, a genus of Pectinidæ.

Fam. 2. *Placunidæ.* This family is represented by the genus Placuna, the shell of which (the only part known) is allied to Anomia and Ostrea. It is imperforate, free, inclined to circular, thin, and foliaceous in texture, translucent, and the valves are so flat that but little room is left for the animal, which must consequently be very thin. In one valve there is a V-shaped tooth, and in the other a corresponding depression; ligament marginal. This and the preceding family are by some included in the Ostreidæ.

Fam. 3. *Ostreidæ.* The genus *Ostrea* (*pl.* 76, *fig.* 25, *O. cristigalli*), well known as an article of food, is widely distributed in various parts of the world, and has been in request from a remote period. The shell is inequivalve and irregular, the ligament partly internal and partly external, and the left and larger valve is usually attached to extraneous bodies. On the western coast of Africa, where the branches of certain aquatic trees hang in the water at high tide, the oysters affix themselves to these

branches, where they may be seen suspended at low tide. There are four lanceolate labial palpi; and the branchiæ, two upon each side, are conspicuous objects when the shell is opened. The very large liver is recognised by its dark color, which causes it to be indistinctly seen through the translucent integuments. There is no appearance of a rudimentary foot, but eyes have been detected.

The ancient Romans were very fond of oysters, and soon discovered those of Britain to be superior to their own, and imported them in winter packed in snow, and in such a manner as to prevent the valves from opening, a mode still practised when oysters are to be transported a considerable distance. Previous to this period Sergius Aurata had invented and practised the art of breeding oysters in artificial beds, turning his art to great profit. This is still practised in the Mediterranean, where ponds are used, into which the sea enters at high tide. About Naples oysters attach themselves to sticks, and here numerous poles are stuck into the bottom, and when the oysters which become affixed to them have acquired a sufficient size to be taken, they are collected by withdrawing the poles. Oysters attain a marketable size in four or five years, although not yet fully grown, large individuals being considered less delicate than those of a medium size. Those are most highly esteemed which have grown in the mouths of rivers, where the water is less saline, and it is probable that their food varies according to the locality. Oysters feed upon infusoria; and when certain green kinds are abundant, they impart a green color to the animal, a color which is often incorrectly attributed to some mineral substance. The extent to which oysters are consumed would exterminate them in accessible localities were they not prolific. A single oyster may eject 50,000 or 60,000 eggs in a year, commencing in the spring and continuing through the summer.

Deshayes does not think the genera *Gryphæa*, Lamarck, and *Exogyra*, Say, are sufficiently distinct from Ostrea; whilst Von Buch, the celebrated geologist, insists that they are founded upon good characters. The former author is inclined to look for variations in the soft parts of allied genera, although in such the shell usually presents the more prominent generic and specific characters. Variations in the shell are as important among the Mollusca as in the teeth and horns of the Mammalia, or the bill and feathers of birds; and, although a species may be found which associates it with two genera, this is not sufficient evidence that the two should be united. According to Deshayes, Ostrea passes by insensible gradations into Exogyra, and this, by equally gradual steps, returns to Ostrea, so that in his opinion the species of the three form but one natural genus.

Fam. 4. *Pectinidæ.* In *Pecten* (*pl.* 76, *figs.* 27 to 29), the chief genus of the family, the shell is regular, toothless, inequivalve, eared at the hinge margin; ligament entirely internal, and placed in a triangular depression; surface often covered with ribs. Mouth with deeply cut lips and a pair of palpi on each side; mantle disunited, margin with numerous cilia, having eyes between them; branchiæ sub-divided into separate parallel filaments; foot small and dilated, a byssus sometimes present. The genus Pecten is

widely distributed in a recent and fossil state, and is not confined to any particular country or climate.

These shells are free, and live upon a surface of mud or sand, from a trifling depth to twenty fathoms, and they are fished up as an article of food. They present several distinct forms, and many of them possess great beauty. Pecten pleuronectes is named after the generic name of the flounder, because one side is dark colored, and the other white. P. jacobæus was formerly worn by pilgrims who had visited the Holy Land. P. quinquecostatus occurs fossil in the cretaceous deposits of Europe and America, and there are numerous species belonging to the tertiary formations of the United States. Lima, a genus of free shells, is allied to Pecten.

Spondylus (*pl.* 76, *fig.* 35) is a genus of attached, rough or spiny, and usually heavy and finely colored shells, allied to Pecten and Ostrea. There are two strong teeth in each valve, and a depression for the ligament. *Hinnites* is allied to Pecten and Spondylus, and possesses the peculiarity of being free until it attains a certain size, when it becomes permanently affixed.

Fam. 5. *Aviculidæ.* This family includes the shells from which most of the pearls of commerce are obtained. They are allied to the two preceding families, and most of the genera are byssiferous, with pearly shells. The large well known shell (*pl.* 76, *fig.* 20), which sometimes attains a size of ten inches, produces the finest oriental pearls, as well as most of the mother-of-pearl which is used in the arts. It forms the genus *Meleagrina*, Lamarck, although it is now considered not to be distinct from Avicula, and it is therefore named *Avicula margaritifera*, Linn. It inhabits the Indian seas. Avicula, according to the celebrated anatomist Poli, has the mantle unclosed, and fringed with tentacular appendages. The foot is small and secretes a byssus.

The genus Malleus (*M. malleus*, Linn., *pl.* 76, *fig.* 26) is remarkable for having the hinge margin extended in some species in the antero-posterior direction. The shell is very irregular, the foot secretes a byssus, and the mantle has a fringe of small tentacles. *Perna* (*fig.* 30) has an irregular shell, hinge straight, with a row of transverse furrows for the insertion of the ligament. The byssus passes through a gaping vacancy in the front of the shell. The genera Malleus, Perna, Vulsella, Crenatula, Catillus Inoceramus, and some others, are placed by some authors in a distinct family, *Malleidæ.*

Pearls are secreted upon the inside of the shell, or in folds of the mantle, the latter being the most regular; and as their quality depends upon that of the nacre, those shells which have this of a fine quality produce the best pearls. The pearls of common oysters are rough concretions of no commercial value, and similar concretions are sometimes formed by univalve species, the mantle of which has, of course, the power of secreting the calcareous matter of the shell. Although pearls are formed out of the same material as the shell, a bead turned out of the latter has not their peculiar lustre, because the arrangement of the material is different, the successive layers being plane in the shell and spherical in the pearl. On this account shaping an irregular pearl does not alter its lustre. Irregular pearls are sometimes worn without being shaped, when the form is agreeable. Pear-

shaped ones have a proper form for ear-jewels, and are highly esteemed. Being composed of carbonate of lime and albumen, pearls are subject to be soiled by the acid in sweat.

Artificial pearls, with a perfect lustre, are made by lining bubbles of very thin glass with the silvery material which lines the scales of freshwater fish, of the genus Leuciscus. This is introduced in suspension, in a liquid, and when dry, wax is introduced to give strength and solidity.

Pearl fisheries are conducted at many places in various parts of the world, but the chief are in the east. Among the most important are those of the Persian Gulf, and the coasts of Coromandel, Ceylon, and Japan. The Persian Gulf has been a favorite locality from a remote period. Panama and the coast of Columbia were good localities formerly. A round and perfect pearl, as large as a pigeon's egg, belonging to Philip II. of Spain, and worth $150,000, was taken at the Island of St. Margarita, on the north coast of South America; and Tavernier bought one from Catifa, in Arabia (an ancient locality), for £110,000.

About $450,000 are annually produced by the fisheries at the Bahrein Islands in the Persian Gulf, which are fished in June and July. At Ceylon the fishing extends from February to the beginning of April, but the fishing days rarely exceed thirty, from many causes. There are various holidays kept by the members of different castes and religions among the divers. A black race from the coast of India profess the Catholic faith, and do not fish on Sunday; and other days are kept as holidays by the heterogeneous population. Storms also interfere with the fishing.

The beds of pearl shells lie at a depth of six or eight fathoms, and the fishing is done by divers who are able to remain under water from a minute to a minute and a half, or even longer. Indeed, the earlier writers upon the subject assert that a diver might remain submerged one fourth or half an hour, but this is an exaggeration.

Pearls from freshwater mussels were sent from Perth to London between the years 1761 and 1764, to the amount of £10,000, but the fisheries were soon exhausted. A pearl weighing thirty-three grains was taken at this locality. The price of these pearls varied from ten to thirty-six shillings an ounce.

The pearl fisheries of Ceylon formerly employed 50,000 or 60,000 men at sea or on shore. Captain Percival, in his account of the island, describes the mode of proceeding. The shore, deserted at other times, presents during the fishing season a busy scene made up of people of various colors and countries; fishers, merchants, brokers, jewellers, speculators in shells before they are opened, and conjurors who are well paid to perform incantations to prevent the sharks from attacking the divers. The chief locality is off the coast of Condatchy, twenty miles at sea. The right of fishing is sold every season by the government to the highest bidder for each of the localities into which the bank is divided, and the purchaser is generally a black merchant. The same spot is not allowed to be fished again for three or four years, and the shell is supposed to arrive at maturity in seven years.

At the firing of a signal gun at ten o'clock at night, the fleet of boats

sets out with the land-breeze, reaching the banks in time to commence fishing at sunrise, and starting on its return with the sea-breeze about noon. A gun is fired when the fleet is seen from the shore, to acquaint the owners with the fact. The shells are placed upon mats in pits, and buried until the animal is rotted and become dry, when the shells are easily opened and the pearls readily found.

Each boat has twenty men and a pilot. Of these ten are divers and ten boatmen, who row and assist the divers. Five dive at a time, and when these come up the other five go down, which gives them time to recover for each successive dive. The boat has five stones, of which each diver takes one to accelerate his descent, and this is attached to a distinct rope, to be drawn up at leisure. These men use their toes with great facility in picking up small objects from the ground, and when one of them is ready to descend he catches the rope which holds the stone with the toes of the right foot, his network bag with those of the left, and the rope which is to draw him up with his right hand, the other hand being employed to close his nostrils. When he reaches the bottom the bag is hung round his neck, and he commences filling it as rapidly as possible, returning in the course of about two minutes, first making a signal with the rope in his right hand. A diver may make forty or fifty plunges in a day, and bring up one hundred shells each time. This takes place in water from thirty to fifty feet deep; and as the pressure must diminish the volume of air in the lungs, the water must enter the nostrils to a greater or less distance. In consequence of this, when the diver emerges, water, and often blood, are discharged from the mouth, nostrils, and ears. Captain Percival states further, that there are divers who can remain under water four or five, and in one case six minutes. Some oiled their bodies and stuffed their ears and nostrils before descending, but this practice was not general.

The Greek divers were celebrated in ancient times, and they seem to have preserved their skill up to the present day. Like those of the Indian seas, they are taught to dive from childhood. Dr. Lefèvre, a French navy surgeon, gives an interesting account of them, having been present when they were employed in recovering property from the vessels sunk at the battle of Navarino. The water was from one hundred to one hundred and twenty feet deep, and yet the divers not only reached the outside of the vessels, tearing off the copper, &c., but they entered the hold and brought out small objects, such as pistols, Turkish pipes, &c. When ready to descend, the Greeks seat themselves upon the edge of the boat, with their elbows upon their knees, and breathe rapidly with short inspirations, making the sign of the cross at intervals. Finally, they take a deep inspiration, and plunge headforemost, having a small rope attached to the thumb of the right hand, by which they may be drawn up when they dive deep.

Dr. Lefèvre, at three different times, carefully noted the time that the divers remained under water, and with the following result: Out of fourteen divers, the shortest period of submersion was fifty seconds; two remained sixty-five; among the longest, two remained under ninety, one ninety-four, one ninety-five, and one ninety-eight, the average being

seventy-six seconds. When the divers emerge, the face is strongly injected, and they often bleed freely from the nose, and sometimes from the ears and eyes. They dive three or four times in an hour, and upon emerging, they put on thick woollen cloaks. The sea is sufficiently clear to enable divers to see objects at the depth to which they go.

The Phocidæ (seals) remain fifteen minutes under water, having not only large lungs, but an adapting peculiarity in the circulation. In a state of inaction they can remain much longer, and when on land as much as two minutes sometimes elapses between each inspiration. According to Frederic Cuvier, the seals in the Paris collection sometimes slept with the head under water for an hour at a time, a period which exceeds that of a harpooned whale. In the case of the whale, however, there is great muscular action, which requires more oxygen than a state of repose demands.

§§ *Dimyaria.*

The second section, Dimyaria, of the tribe Elatobranchia, includes the two sub-sections, **Mytilacea* and ***Cardiacea*, the first of which includes the four families, 1. Mytilidæ; 2. Arcidæ; 3. Unionidæ; 4. Carditidæ.

Fam. 1. *Mytilidæ.* This family includes the genera *Mytilus* (*pl.* 76, *fig.* 22) and several allied genera, and *Pinna* (*figs.* 18, 19). These animals have a linguiform foot, which secretes a byssus by which they are attached to rocks, the byssus being at first applied by the foot. The shell is equivalve, but very inequilateral, so that the umbones or beaks, which are usually situated about the middle of the back, are here placed at or near the anterior extremity of the shell. In Mytilus the lobes of the mantle are disunited, except at a single point posteriorly, which separates the anal siphon. The anterior adductor muscle is much smaller than the posterior one. Lithodomus is a sub-cylindrical bivalve, which, in its young state, is suspended to rocks by a byssus; but it subsequently perforates the rocks, and lives in a cavity but little larger than the shell, and then the byssus disappears.

The genus Mytilus is used for food, under the name of mussel. Mytilus choros, which is found at Chiloe and other parts of the western coast of South America, attains a length of seven or eight inches; and as the animal is as large as the egg of a goose, and of a fine flavor, it is much esteemed. The favorite mode of cooking it is to make a fire upon flat stones in a pit, and when these are sufficiently heated, the fire and ashes are removed and the shell-fish deposited, and covered, first with leaves, &c., and then with clay. This mode of cooking is practised on the coast of Australia, and in the islands of the Pacific.

The common mussel, Mytilus edulis, is easily taken, as it lives in shallow water, and even between high and low water, upon both sides of the north Atlantic. The shell is smooth, and of a blue or violet color. This species is poisonous to some constitutions, perhaps one in a hundred, and it is possible that this quality depends somewhat upon the season. An emetic, followed by castor oil, is recommended when bad symptoms arise from eating this shell-fish. The symptoms appear in one or two hours, and they

are either internal inflammation, eruption, or resembling a catarrh or asthma, sometimes terminating fatally.

The genus Pinna has a somewhat triangular shell, pointed anteriorly, and it includes several species which attain to a great size, as *P. rudis* (*pl.* 76, *fig.* 19), which is a foot and a half long. The byssus of several species is fine and silky, and six inches or more in length. It is manufactured at Palermo and parts of Italy into gloves, stockings, and other small articles of dress, which are expensive, and kept as curiosities. The mollusc is eaten, and it produces small amber colored pearls.

From a remote period various fables have been current about the pinna and certain small crabs which are found in the shell, as in mussels, oysters, and other shell-fish. When the pinna opens its shell, the cuttle-fish, it is said, "rushes upon her like a lion, and would always devour her but for another animal whom she protects in her shell, and from whom in return she receives very important services." When the crab goes out and sees the cuttle-fish approaching, it "returns with the utmost speed and anxiety" to the pinna, "who, being thus warned of the danger, shuts her doors and keeps out the enemy." Pliny's story has been often repeated. according to which small fishes enter the shell to feast upon the animal, which does not regard their nibbles until the *pinnoteres* or *pinnophylax* gives it a bite, which causes it to close the shell, and thus to kill the fish. some of which is given to the crab as a reward for its watchfulness. Even in the present day similar fables are still recorded by careless compilers.

Fam. 2. *Arcidæ.* The genus *Arca* (*pl.* 76, *figs.* 31, 32) has a byssus in some species; the foot is split, the mantle is open, and the anomaly of two hearts is presented. The hinge margin has a row of numerous teeth, which fit between those of the opposite valve. The shell is rather thick, elongated, oblique, and has the beaks distant. Some species, as A. tortuosa, are curiously curved. In Pectunculus the shell is more nearly circular in outline, and the line of the teeth partakes of the curvature of the shell. In Nucula the lines of the teeth before and behind the beaks form an angle with each other.

The tertiary beds of the United States contain about thirty described species of Arca, and about the same number of Pectunculus. The genus Trigonia is by some authors made the representative of a distinct family, which is objected to by Deshayes and Agassiz. A single living species, T. pectinata, inhabits the seas of Australia. The fossil species are numerous, and extend from the Lias to the Cretaceous group. A single tertiary species occurs in Bolivia. The genus has been illustrated in a masterly manner by Agassiz in his Etudes critiques sur les Mollusques fossiles: Neuchatel, 1840. *Trigonia thoracica* (Morton's Synopsis, &c. p. 65, pl. 15, fig. 13) is from the cretaceous formation of the United States.

Fam. 3. *Unionidæ.* To this family the name of *Nayades* was given by Lamarck, but it is now usually restricted to an order of plants. It includes the greater part of the freshwater bivalve shells, which are so abundant in the waters of the United States, where they surpass, in number and variety of species, those of any other country. They usually live in sand or mud,

ploughing furrows in their course, the ventral half of the shell being generally sunk in the bottom, which gives it a vertical position. Some inhabit gravel bars; and as it is difficult for them to progress through such an unyielding material, these species seldom change their place. A few species, as the genus Mycetopus, live in perforations made apparently with the foot, which has a peculiar development. These species of Unio, when left dry by the fall of the rivers, bury themselves in the moist sand. Unio (Truncilla) triqueter, a shell much like *pl.* 76, *fig.* 38, where we have observed it in the Ohio, does not take the more or less horizontal position of those like *pl.* 76, *figs.* 21, 47, but the anterior extremity is sunk diagonally into the mud or gravel, so as to bring the posterior truncation level with the bottom.

The shell is composed of nacre, and varies from little more than the thickness of paper to half an inch, or more, according to the species. It is covered with a periostraca, usually colored with various tints of yellow, green, or brown, sometimes ornamented with markings or radiating lines of a different color, among which green upon a yellowish ground is the most frequent. The surface is plain, as in the species inhabiting the rivers of the Atlantic coast of the United States, or with undulations or knotty projections, as in those of the tributaries of the Mississippi. Two species, *Unio spinosus*, Lea, from Georgia, and *U. collinus*, Conrad, from Virginia, have a few spines upon the shell. The beaks, being the oldest part, and the most exposed to the action of abrading agents, are subject to be worn off, and to such an extent that the younger portion in some cases disappears, and is replaced by successive secretions of shelly matter from the mantle. This renders it difficult to refer young and old shells to the same species. On this account no cabinet can be deemed complete without series indicating the gradual changes and variations in size, and other characteristics to which individual species are subject.

The variation in external character is extremely great in this family, where the same species will, in some instances, vary more than distinct species, which present more uniform characteristics. The variations of Unio complanatus (one of which is well represented in *pl.* 76, *fig.* 47) are so great that not less than fifty specimens are required to illustrate it properly.

The Unionidæ inhabit the rivers and ponds in Europe, Asia, Africa, Australia, both Americas, and particularly those of the United States. Their distribution here has not been as thoroughly studied as it deserves to be, but the following facts may be stated. The species inhabiting the rivers of the Atlantic coast (excepting U. viridis, which is found in Kentucky, and U. cariosus, which has been taken in White River, Indiana) do not occur in the tributaries of the Mississippi. A few western species, as U. alatus, siliquoideus, ventricosus, and pressus, have found their way through New York, as far east as Lake Champlain. U. rectus is found on the southern border of Lake Superior, in Lake Champlain, the Ohio and Alabama rivers, presenting a wide range. U. complanatus, although it seems not to be found in the tributaries of the Mississippi, occurs in some

of the streams of the southern shore of Lake Superior, and thus belongs to the basin of the St. Lawrence: it is found in Maine, and probably in every river as far south as the Savannah. Species are found in east Tennessee, as U. intermedius and subtentus, which are not found in Kentucky or the States on the south; and Louisiana has species not found beyond its limits. Unio plicatus and siliquoideus (the latter found in Lake Champlain, and the former above Pittsburgh, and in Grand river, Michigan) are found as far towards the southwest as San Antonio in southern Texas. U. lanceolatus has no greater range than from Tar river, in North Carolina, to the James and Rappahannoc in Virginia; and U. collinus, subplanus, and constrictus, seem not to extend beyond James river.

The following table exhibits the distribution of some of the species of the Atlantic rivers, from the Connecticut to the James. Asterisks under the name of a river denote the presence of a species in it, and dots indicate where it has not been found. The three first on the list extend into Maine:

	Connecticut,	*Hudson,*	*Delaware,*	*Susquehanna,*	*Potomac,*	*James.*
U. complanatus,	* * *	* * *	* * *	* * *	* * *	* * *
radiatus,	* * *	* * *	* * *	* * *	* * *	. . .
ochraceus,	* * *	* * *	* * *	. . .	* * *	* * *
cariosus,	* * *	* * *	* * *	* * *	* * *	* * *
heterodon,	* * *	. . .	* * *	. . .	* * *	. . .
nasutus,	* * *	* * *	* * *	. . .	* * *	* * *
viridis,	. . .	* * *	* * *	* * *	* * *	* * *

The Unionidæ admit of being divided into three sub-families: *Unioninæ*, *Iridininæ*, and *Etheriinæ*.

Sub-fam. 1. *Unioninæ.* The labial palpi are four: the foot is large and linguiform; the mantle is not united, and the posterior siphons are not tubular, being formed by the mere contact of its posterior margin on each side, but leaving two openings. The extremity scarcely extends beyond the shell; it is papillate, and provided with eyes which have the power of distinguishing light from darkness, as the siphons are suddenly withdrawn when a shadow is cast upon them. Some genera of this sub-family present no distinctive characters by which an Unio or an Anodonta, &c., can be distinguished without the shell, and on this account some authors insist that a character is worthless in the shell if unaccompanied by some distinction of the soft parts; and forgetting that the shell is part of the animal as the bill is part of a bird, they insist upon having two characters instead of one.

In the genus Unio there are two cardinal teeth in each valve anteriorly, and a lamellar tooth posteriorly in the right valve, fitting between two in the left one.

Anodonta has the hinge margin without teeth, and the shell is usually thin in texture.

Alasmodonta has cardinal teeth, but no lamellar teeth. Say founded this genus in 1818, and it was named Margaritana by Schumacher, in a work, the title-page of which bears the date of 1817. "The priority of this date

would lead me to adopt the name given by that author, did it not appear that the work was not published for several years after it was printed. It was not known to the naturalists of this country, France, Germany, or England, until the year 1824." (Say's Am. Conchology.) Swainson uses both names, restricting Schumacher's to the *Margaritifera* (*pl.* 76, *fig.* 47) of Europe, and Say's to the form A. undulata.

Strophilus, Rafinesque, 1820 (*Pseudodon*, Gould, 1844, Proceed. Bost. Soc. p. 160, with four species), has a small swelling instead of regular cardinal teeth, and the soft parts differ in having the young, after they leave the ovaries, deposited transversely in the exterior branchiæ, instead of being in vertical folds, as in most of the species. In Diplasma of the same author, founded on some shells from Hindostan, there are anterior as well as posterior lamellar teeth, and these are double in the right valve anteriorly, and in the left posteriorly.

Rafinesque, in the "Continuation" of his Monograph of the Bivalve Shells of the river Ohio, institutes a genus, Loncosilla, for a solenoid shell, brought by Dr. Burrough from the river Jellinghy, in Bengal. Rafinesque considered it to be allied to Anodonta, on account of its fluviatile habits, but the characters of the shell are such as to induce us to coincide with Dr. Burrough in believing it to be essentially a solen. The shell is less than an inch long, "somewhat swelled, both ends rounded, and a little gaping, back horizontal; outside and inside smooth and whitish."

Lamarck considered these mollusca to be hermaphrodite; and the dissections of competent anatomists, such as Neuwyler and Van Beneden, confirm this view.

Dr. J. P. Kirtland of Cleveland, well known as a successful cultivator of natural science, announced, in the twenty-sixth volume of Silliman's Journal, his ability to distinguish the sexes by the shell alone in this subfamily. It is well known that the shells of many (although not all) species present individuals which are more full at the base posteriorly, and these were assumed to be females, the enlargement of the shell being, as it was thought, required for the gravid branchiæ. Some species, as Unio viridis, may be gravid without exhibiting any change of external form. If some individuals remain barren, and others prolific through a course of years, it is possible that the weight of the gravid branchiæ may cause the soft parts to descend and bring with them the shell-secreting mantle, which may account for the enlargement without recourse to the theory of separate sexes, which are not found in the allied families. But this explanation will hardly account for the second form in Unio velum or U. flexuosus, or for the extraordinary transverse diameter (as in Unio siliquoideus) which is sometimes assumed in addition to the more common posterior enlargement.

Dr. Kirtland has discovered the presence of a line which he compares to a byssus (Silliman's Jour., 1840, vol. xxxix. p. 166), by which the young of various species of Unio attach themselves to extraneous objects, a character which indicates an affinity with the Arcidæ and Mytilidæ, with which they have other affinities.

The genus Castalia, from the rivers of South America, is allied to Arca

and Trigonia in form, and to the latter by some affinity in the teeth. It was placed next to Trigonia by Lamarck, but an examination of the mollusc shows that it is allied to Unio, and the same remark applies to Hyria. The propriety of making a single genus of all these is doubtful, genera being thus made to depend upon the number of species, because the more numerous these are, the more links will there be between dissimilar forms. If Castalia and Unio were distinct genera when the number of species was small, they are still distinct, and the generic basis established by Deshayes in malacology and Temminck in ornithology untenable. (Desh. in Lam. Animaux sans Vertèbres, 6,523.) Some might extend these views to species, and deny specific distinctions in those genera which have many species, and this has been done by Lamarck in Cerithium, but he is consistent in extending his views to species in general.

Some have gone so far as to assert that the family of Unionidæ contains not only a single genus but a single species. Without inquiring how the term *species* is to be limited, we feel confident that most of the Uniones can be determined specifically, as well as most genera of conchifera. The spines of Unio spinosus and U. collinus are often lost with age, and yet there is no difficulty in distinguishing them. U. trapezoides was confounded by Lamarck with one or two other species, yet no great knowledge is requisite to distinguish it. Deshayes doubts the distinctness of Unio lanceolatus, yet a very slight examination is sufficient to show that it is different from all others. Unio subtentus, viridis, cylindricus, heterodon, and a host besides without prominent characters, can always be distinguished.

Sub-fam. 2. *Iridininæ.* This sub-family contains some shells which have a great resemblance to Anodonta, and others which have teeth upon the hinge margin much as in Arca, and which are represented by the transverse elevations upon the teeth of Castalia. Iridina is generally elongated, and differs from the Unioninæ in having the mantle closed posteriorly, the siphons tubular, short, unequal, and without the retractor muscles of the marine genera with long siphons. *Iridina blainvilliana*, Lea (*Anodonta* or *Columba*, Am. Phil. Tr. v. 77, fig. 35), may be an exception, because the unusual curve in the pallial impression indicates a considerable power to retract the siphons.

The genus *Iridina* was established by Lamarck upon I. exotica (also named *nilotica* and *elongata*) in which the hinge is smooth, but acquires granulations with age, when it conforms to Lamarck's characters. It is also named *Spatha*, Lea, 1837, and *Calliscapha*, Swainson, 1840.

The genus Pleiodon was founded by Conrad, in 1834 (J. Acad. Nat. Sci., vol. vii. p. 178, pl. 13, *P. ovata*, Swainson), for a shell from Liberia in which the teeth "are alternately inserted, a generic character widely differing from Iridina, which is simply crenulated or tuberculated on the margin of the hinge." The teeth are further compared with those of Arca and Nucula. In a specimen now before us there is a flat internal ligament at the anterior internal extremity of the teeth.

Sub-fam. 3. *Etheriinæ.* The genus Etheria presents an irregular and very variable shell, without teeth, and somewhat resembling that of Ostrea, and

although it is attached (indifferently by either valve), it is provided with a large foot. Before the mollusc was known, it was placed near Chama, but its affinities are with the Unionidæ; it resembles Iridina in having the extremity of the branchiæ united by a small connexion forming the superior siphon. The shell is nacreous, covered with a periostraca, and formed like some species of Ostrea, with laminated cavities, which are so large that the shell is proportionally lighter than that of any other species. They inhabit the Nile from the first cataract upwards, and the Senegal two hundred leagues from its mouth; and Dr. Goheen brought several imperfect specimens from the upper St. Paul's in Liberia, several hundred miles from the sea. Several species are known.

The genus Mulleria is said to be founded upon young specimens of Etheria.

Fam. 5. *Carditidæ.* In Cardita the mantle is united for a short space posteriorly, forming a short anal siphon. It has three or four pair of truncated palpi; the shell is suborbicular or transverse, generally ribbed, and the two cardinal teeth are oblique. This genus occurs plentifully in a fossil state.

** *Cardiacea.*

The sub-section Cardiacea of the section Dimyaria contains the families: 1, Chamidæ; 2, Tridacnidæ; 3, Cardiidæ; 4, Cycladidæ; 5, Tellinidæ; 6, Lucinidæ; 7, Veneridæ; 8, Crassatellidæ. In these the mantle is closed posteriorly, and the siphons are united or distinct.

Fam. 1. *Chamidæ.* This family includes Chama, Diceras (somewhat doubtful as a distinct genus), and Cleidothærus. In Chama the shell is irregular, spinous or rough, and attached, with the valves unequal and the umbones involute. The hinge has an oblique stout tooth fitting into an opposite cavity. The species present many varieties, chiefly from taking the form of the bodies to which they affix themselves. Cleidothærus resembles Chama, but is remarkable for having an internal accessory piece held by a portion of the ligament.

Fam. 2. *Tridacnidæ.* This family is represented by the genus Tridacna, which includes the largest species of shell known, *Tridacna gigas* (*pl.* 76, *fig.* 33). The position of the animal in the shell differs from that of most bivalves, as the foot passes through an opening in the lunule upon the closed or hinge margin of the shell; to effect which the position of the animal is changed so as to bring the open foot of the mantle above. The mantle is nearly closed, leaving a small anal aperture, a large branchial one, and a third corresponding to the lunule, for the foot, which is large and byssiferous. The anterior adductor muscle is obsolete, or confounded with the large posterior one, the two being very close together, forming a single impression.

The shell of Tridacna gigas is said to attain a length of three or four feet, and a weight of 300 pounds. The French name them *benitiers*, from the use made of them in the Catholic churches to contain holy water. The significant name of the genus was applied by the ancients to certain oriental oysters, which were so large as to require *three bites* in eating them. The mollusc of Hippopus resembles that of Tridacna; and although the shell has no opening, this part varies much in size among the species of

Tridacna, so that the two genera are now usually united. It may be remarked that the lunule of Hippopus is not entirely closed.

Fam. 3. *Cardiidæ.* In this family the siphons are very short. In Cardium (*C. echinatum*, *pl.* 76, *fig.* 42) the foot is long, slender, and bent forwards at an angle in the middle, and with the aid of it the mollusc can leap with considerable force. The species live buried in sand and mud. Cardium edule is eaten extensively in Europe. It is so abundant in the North Sea that shiploads are raked up and taken to Holland and other places to be burnt into lime, and a good locality will furnish 200 or 300 cargoes. *Hemicardium cardissa* (*pl.* 76, *fig.* 41).

Isocardia (*I. cor.*, *pl.* 76, *fig.* 34) has a subglobular shell, with the prominent umbones curved or contorted. The species figured inhabits the Mediterranean and the coast of Ireland.

Fam. 4. *Cycladidæ.* This family includes certain freshwater genera which have a general resemblance to marine forms, as Cardium, Tellina, and Venus. They have generally a smooth olivaceous periostraca.

Cyclas (*pl.* 76, *fig.* 43) is a genus of small subglobular shells from one eighth to one half an inch or more in size, inhabiting ponds and streams, sometimes upon the bottom and sometimes beneath it. The foot is long and tongue-shaped, the mouth closed posteriorily, and there are two retractile siphons. Besides the small diverging cardinal teeth, there are short anterior and posterior lamellar teeth. When kept in vessels of water, it is said that they can traverse the surface with the aid of the foot, the body being suspended beneath.

Pisidium is allied to Cyclas, but it is more wedge-shaped, and there is but one siphon. *P. dubium*, Say (*Cyclas*), Gould, Invert. of Mass. p. 75, fig. 56; *P. abditum*, Hald., 1841; Proc. Acad. N. S. i. 53, has a strap-shaped foot covered with vibrillæ, and considerably longer than the shell; and it can be extended, attached, and the body drawn up. The animal advances in this manner over the bottom of a smooth dish, being sometimes vertical and sometimes throwing itself upon one or the other side. The longer or wedge-shaped end of the shell goes foremost and is anterior; and although the foot is chiefly extended in this direction, it can be turned backwards, and indeed its flexibility is such as to allow it to be extended in any direction. The shell is one eighth of an inch long, pale yellow, the lines of growth very fine, the cardinal teeth indistinct, and the lamellar teeth robust. Lives in springs beneath the mud. The siphon is scarcely protruded beyond the margin of the shell, as it is in most species of Cyclas. Immature young are found within them, as in Cyclas.

Cyrena is a genus containing much larger and heavier shells than Cyclas, and chiefly confined to the fresh waters of warm climates. Cyrena carolinensis and Rangia cyrenoides (or Gnathodon cuneatus) are found in the southern United States both recent and fossil. The latter has some affinities with Mactra.

Megadesma is represented by a single species (*reclusa*, Chemnitz; *paradoxa*, Born; *radiata*, Lamarck), about three inches long, thick in texture, of a triangular form, green with violet rays, the inside white

clouded with violet, and the pallial impression curved. The older authors placed it under Venus and Tellina. It inhabits Junk river and other rivers of west Africa near the mouth.*

Glaucomya of Gray belongs here. Mr. Cuming found it living in the fresh waters of the Philippines, and it occurs fossil in the freshwater formations of Paris. It was at first confounded with Venus.

Fam. 5. *Tellinidæ* (also named Nymphacea). In this family the cardinal and accessory teeth are well developed, the shells are seldom covered with a periostraca, the mantle is margined with very sensitive tentacular appendages, and closed posteriorly, the siphons are exserted, and the pallial impression has a deep sinus.

Donax (*pl.* 76, *figs.* 38, 39) has a wedge-shaped shell, truncated upon the posterior slope, making this extremity unusually short. Some authors, as Swainson, have mistaken the posterior for the anterior extremity, although the short ligament and the curve in the pallial impression should have prevented such an error. Donax is a genus of handsome and usually small shells, abundant in individuals, and living vertically in the mud at a trifling depth of water. A few species are found in tertiary formations. Capsa includes shells allied to Donax, but without accessory teeth.

Tellina (*pl.* 76, *fig.* 44) is a genus of handsome and usually elongated shells with a fine nacre, often polished and radiated externally, and in some cases rough. The recent species are numerous, and there are a considerable number of fossil species in the tertiary of Europe and America.

Blainville places Amphidesma as a section of Lucina; Latreille considers it the representative of a family; and Deshayes thinks it has characters intermediate to Mactra and Tellina, to the latter of which he surmises that the unknown animal is allied.

Fam. 6. *Lucinidæ.* This family is sometimes united to the Tellinidæ. Lucina presents some important distinguishing characters. The shell is suborbicular, white or pale colored; the labial palpi are absent, the branchiæ of each side are united so as to appear single, although separable; the foot is vermiform, and there is a single anal siphon capable of being turned within itself like the finger of a glove. The branchial siphon is reduced to a simple perforation. The genus has numerous species, recent and fossil in the tertiary formations.

Fam. 7. *Veneridæ.* This family contains the extensive genera *Venus* (*pl.* 76, *fig.* 36) and *Cytherea* (*fig.* 37), and also *Arthemis* of Poli. The species of Venus and Cytherea being numerous, the accessory tooth which distinguishes the latter is found more or less developed, and as it is at times reduced to a mere vestige, Deshayes is inclined to consider the genus as

* Magadesma of Bowditch was probably published in his treatise on Conchology. It was named *Galathea* by Bruguières, a name which has been already used. Sowerby called it *Potamophila*, and De Roissy *Egeria*, a name which occurs three times in Entomology, being instituted by Dumeril in 1806, Fabricius in 1808, and Desvoidy in 1830. Leach used it in 1815 in the Crustacea, and Lea in 1833 in the Mollusca. The constant use of Agassiz' important and laborious Nomenclator Zoologicus (containing 33,000 names of genera, &c.) can alone prevent such confusion.

not well founded. It is adopted by most conchologists, although rejected by Linnæus, Cuvier, and Blainville.

This family contains some of the most beautiful forms and finely colored species, both in tint and pattern, among bivalve shells. There are upwards of 150 living species, and the fossil species are also numerous, and chiefly found in the tertiary strata. There have been about sixty tertiary species named from the formations of the United States. Venus mercenaria is an inhabitant of both coasts of the North Atlantic, and is used for food. In the markets of Philadelphia it bears the name of *clam*, and in Boston that of *quahog*. The colored margin of the shell was used by the aborigines in the manufacture of their wampum. *Cytherea dione* (*pl.* 77, *fig.* 37) is remarkable for its longitudinal sulcations, and the double rows of long spines posteriorly.

Fam. 8. *Crassatellidæ.* This family is represented by the genus Crassatella, the mollusc of which being unknown, its affinities are doubtful. There are about twenty recent species known, and a considerable number of fossil ones, chiefly tertiary, but also cretaceous. Some authors place the genus Astarte (also called Crassina) here, but Deshayes thinks the mollusc (which is unknown) has an affinity with Venus.

Class 2. *Gastropoda.*

This class includes most mollusca with univalve shells, whether spiral or not, as well as species without a shell. The head, absent in the Acephala, is here present; and on its presence Blainville's appellation of Paracephalophora is founded, a character which is of more importance than the foot.

Order 1. Polythalamia. This, the first systematic name applied to these animals, was proposed by Soldani, 1789. More recently they have been studied by D'Orbigny, who is the chief authority upon them, and by Dujardin. The original name is defective, and both these authors have conferred French names upon them, in contempt of those rules which keep nomenclature pure and uniform, names which are of no more account than the German name *Bauchfüszler* instead of *gasteropoda;* and should the systematic name be adopted subsequently to such a vernacular one, and be a translation of it, the author of the latter cannot be quoted for the systematic name.

These animals have been also named Foraminifera and Rhizophoda. Their classification is difficult. Their shell bears a distant resemblance to that of certain cephalopoda, and on this account they were for a considerable period referred to this class. D'Orbigny considers them as a distinct class between the Echinodermata and Zoophyta, and Dujardin regards them as acalephæ, and as allied to infusorial forms like Amiba and Difflugia. Agassiz regards them as the lowest form of the gasteropodous mollusca, and we place them provisionally here, although they seem to have neither head nor foot, two important organs in this class. The apparent want of viscera indicates a position below that of the Bryozoa, and although the locomotive organs may be assumed as giving them a higher position, these are probably merely a modification of the tentacles.

These animals are microscopic, glutinous, and translucent, but tinted with bluish, reddish, brown, or yellow, the tints being uniform in each species. The soft parts are inclosed in a calcareous (rarely cartilaginous) shell, fitted to the varied outline of the body, and presenting numerous variations in form, affording characters for genera and higher groups. It has one or more openings, or numerous pores, which allow egress to certain filaments used as organs of locomotion. These can be extended to six times the diameter of the body, and they recall the allied organs in the Echinodermata and Cirrigrada. They are ramified like the branches of a tree, and have the power of secreting calcareous matter upon the outside of the shell, in which they resemble the extensions of the mantle in some orders. The characteristic name Rhizopoda of authors, has been drawn from these filaments.

The Polythalamia inhabit most seas, and they are so abundant that D'Orbigny calculated that an ounce of sand from the Antilles contained 3,840,000 individuals. The same author informs us that these little beings from a sixth to half a millimetre long, are more abundant than the minute crustacea, or the infusoria whose shields form the tripoli of commerce. Banks are formed by them dangerous to navigation; they obstruct bays and straits, of which the celebrated harbor of Alexandria is an example; and with the coralligenous zoophyta they form reefs and islands.

In a fossil condition they are no less conspicuous. In Russia calcareous beds are formed by a single species of Fusulina, and various species enter largely into the composition of chalk and certain tertiary formations. They are so abundant as in some cases to amount to 3,000,000,000 in a cubic metre; and the city of Paris and the surrounding towns are almost built of them, so abundant are they in the materials used. Dr. Buckland makes the following remarks: "Nummulites are so called from their resemblance to a piece of money; they vary in size from that of a crown piece [!] to microscopic littleness, and occupy an important place in the history of fossil shells, on account of the prodigious extent to which they are accumulated in the later members of the secondary, and in many of the tertiary strata. They are often piled on each other nearly in as close contact as the grains in a heap of corn. In this state they form a considerable portion of the entire bulk of many extensive mountains, *e.g.* in the tertiary limestones of Verona and Monte Bolca, and in secondary strata of the cretaceous formation in the Alps, Carpathians, and Pyrenees. Some of the pyramids and the sphinx of Egypt are composed of limestone loaded with nummulites. It is impossible to see such mountain masses of the remains of a single family of shells thus added to the solid materials of the globe, without recollecting that each individual shell once held an important place within the body of a living animal; and thus recalling our imagination to those distant epochs when the waters of the ocean which then covered Europe were filled with floating swarms of these extinct molluscs, thick as the countless myriads of *Beröe* and *Clio borealis* that now crowd the waters of the polar seas. Lamarck, in his observations on *Miliola*, remarks that these very minute animals have had much more influence on the masses which

compose the surface or exterior crust of our globe than the remains of elephants, hippopotami, and whales."

Viewing this group as a class, D'Orbigny divides it into six orders, each of which, excepting the first, is subdivided into two families. Of the recent species, 68 genera and 900 species are known, more than half of which belong to the warm seas. D'Orbigny's opinion of their classification is as follows: Though less complicated in their organization than many zoophyta, they have not a common life, nor are they aggregated like them, whilst their locomotive powers and testaceous envelope place them much higher. On the other hand they are in all respects less complete than the echinodermata; and judging from the radiation of their filaments, the position of the foraminifera is in Cuvier's radiated division, between the Echinodermata and the Zoophyta, as a distinct class.

Order 2. Pteropoda. This order takes its name from two large expansions, one on each side anteriorly, which are analogous to the wings of a butterfly both in appearance and action, being used in locomotion. This order was considered by Lamarck and Cuvier to form a distinct class, but Blainville and other distinguished naturalists are of opinion that its contents are essentially gasteropoda. Some species, as *Clio borealis* (*pl.* 76, *fig.* 78, one inch long), are naked; others, as *Hyalæa*, are provided with a delicate shell. These molluscs are monoicous, and swim about in the sea without the power of creeping or attaching themselves to solid bodies. This order contains the families *Hyalæidæ*, *Clioïdæ*, and *Phillirhoïdæ*. In Hyalæa the branchiæ are composed of pectiniform transverse laminæ or *leaves*,* a character which would afford a name for the order in consonance with those of the allied orders, because Cuvier's name, *Heteropoda*, appertains to the group as a class.

Fam. 1. *Hyalœidæ.* The shell of Hyalæa has a delicate texture and curious form, bearing a distant resemblance to that of Terebratula, to which the genus was at one time referred. The shell which covers the abdomen is translucent, subglobular, and has the appearance of a bivalve in which the two valves unite in a single piece without a hinge. The mollusc has two stout tentacles and two lips, and the wing-like expansions are placed near the mouth. They live in the high seas, seldom approaching the shores, flapping themselves along with great facility, and descending when disturbed. Being extremely abundant where they occur, they are devoured in great numbers by whales and other animals. Cleodora and Limacina are other genera.

Fam. 2. *Clioïdæ.* Clio has six retractile tentacles in two groups, and a rudimentary foot. Clio borealis is abundant in the north polar regions, where it is eaten by whales and fishes.

Fam. 3. *Phillirhoïdæ.* The head of Phylliroë is lengthened, and bears two tentacles, the snout is retractile, and the body is gelatinous and transparent, very much compressed laterally, and provided with a caudal fin. According to Peron and Lesueur the branchiæ are internal, and in the form

* The group which Latreille named *Phyllobranchia*, had already been provided with a name.

of granular cords, but Quoy and Gaimard could not detect these organs. Some authors place this family among the Caryobranchia.

ORDER 3. CARYOBRANCHIA. The body is gelatinous, transparent, and capable of being enlarged by absorbing water. The head is proboscidiform; the foot is long, compressed, or vertical, provided with a little sucker, and used as a fin in swimming. The animal is usually inverted in the water, the foot being above.. The branchiæ are pectinated, and arranged around a nucleus, whence the name of the order. Some of the *Heteropoda* of Lamarck belong here. The order has the additional half Latin and half Greek hybrid name *Nucleobranchia*, which is inadmissible.

Fam. 1. *Atlantidæ.* The genus Atlanta has an extremely delicate, vitreous, transparent shell, shaped like planorbis, with the aperture trumpet-shaped, with one side deeply excised, and having a closely fitting operculum, of the same texture as the shell, the spire projecting from one side. The mollusc is spiral and compressed, the foot large, compressed, and provided with a small sucker above. Eyes two, behind the tentacles. This genus is found far at sea, swimming with great facility, and sinking when not in action. Deshayes thinks the fossil genus Bellerophon is allied to this genus in its natural affinities.

Fam. 2. *Carinariidæ.* The shell of *Carinaria* is extremely delicate, and much smaller than the animal (*pl.* 74, *fig.* 17, on the right hand below). Its resemblance in form, and in having a single chamber, induced some authors formerly to place it near *Argonauta* (*pl.* 76, *fig.* 17), with which the animal has no affinity. The mollusc is gelatinous, transparent, and rough; the eyes two, situated at the base of the tentacles. The heart and branchiæ are contained in the shell, and opposite to this is the compressed foot (or ventral fin), the posterior extremity being provided with another fin. The Carinariæ are found at sea, and are supposed to feed upon minute crustacea. They can attach themselves to floating bodies with the aid of the sucker upon the foot.

Fam. 3. *Pterotracheidæ.* This family is allied to the preceding one, but the tentacles and shell are wanting. The former are reduced to tubercles (or entirely absent) with the eyes on the outside of their base. A membrane supplies the place of the shell of Carinaria. Pterotrachea (also named Firola) is the principal genus. The habits are identical with those of Carinaria.

Fam. 4. *Pterosomidæ.* Composed of the genus Pterosoma, in which the body is cylindrical, surrounded horizontally with a broad marginal membrane used in swimming. Neither tentacles nor branchiæ were observed. P. plana is nine centimetres long, and inhabits the sea between the Moluccas and New Guinea.

ORDER 4. GYMNOBRANCHIA (also known by the hybrid term of *Nudibranchia*). The members of this family are without a shell or a branchial cavity, the organs of respiration are in the form of external appendages upon the back, and their distribution and shape afford characters for the families. The embryonic young have a shell, and they remind us somewhat of Atlanta. These animals are monoicous; they have a large flat disc or

foot to move upon, and their food is either vegetable or animal, some preferring one kind and some another.

Fam. 1. *Dorididæ.* In this family the branchial plumes surround the vent in the form of a flower, situated upon the upper surface towards the posterior extremity (*pl.* 77, *figs.* 16, 17). The upper part is composed of a kind of large mantle, the jaws are corneous, the tentacles four in number, two dorsal and two labial. The dorsal tentacles and the branchiæ are sometimes retractile.

Doris includes many species whose brilliant coloring renders them conspicuous objects. The dorsal tentacles have transverse ridges variously disposed in the different species; the branchiæ are subdivided in a regular manner, but not uniformly in the different species. The eggs are deposited to the number of several thousand in a ribbon-shaped mass attached by its edge to extraneous objects, and wound in a spiral, varying from one to five or more turns. These animals live upon stones and marine plants; they move very slowly, and are not much addicted to locomotion. The length varies from about half an inch to six or seven inches.

Fam. 2. *Tritoniidæ.* In this family there is a membranous veil or expansion in front, above the mouth (*pl.* 77, *fig.* 2); the branchiæ are in two longitudinal rows, and laminated, plumose, or papillate; two dorsal retractile tentacles. *Tritonia* (*pl.* 74, *fig.* 20), *Tethys* (*pl.* 77, *fig.* 2).

Fam. 3. *Eolididæ.* "Branchiæ papillose or branched, arranged on the sides of the back; stomach simple." (Alder and Hancock.) These authors divide this family into two sub-families, *Malibæinæ* and *Eolidinæ*, to which *Glaucinæ* may be added. The first contains the genus *Dendronotus*, of which *D. arborescens*, Muller, is found upon both sides of the North Atlantic. It is beautifully figured from specimens taken at Boston, by Mr. Couthouy, in the Bost. Jour. Nat. Hist., vol. v. Dr. Gould compares its branchiæ to some fifteen or twenty widely and numerously branched plants. See his Invertebrata of Massachusetts, pp. 4–7, for descriptions of various species in this order.

In *Eolis* the branchiæ are elongated papillæ resembling short cords arranged in longitudinal rows, and sometimes so numerous as to cover the back entirely. *Eolis salmonàcea* of Couthouy has about a hundred of them. They are frequently tinted with several bright colors, when they add much to the beauty of the various species.

Glaucus has the branchiæ (which are used in swimming) in symmetrical pairs upon each side, each being a wing-like projection, with the margin fringed with numerous filaments. There are three or four pair, according to the species, the anterior being the largest, and the remaining ones becoming gradually smaller. Deshayes doubts whether these organs are branchiæ, since they are cast off by the animal when disturbed; and indeed Couthouy expresses the same doubt in the case of Eolis, from which they can be cast off, and, when cut off, the animal does not seem to suffer much. He regards them as accessory to the general surface in the operation of oxygenating the system. The papillæ in one species dissected by Alder and Hancock contain a hepatic gland in the middle, and a circulation of

blood towards the margin. The surface is covered with vibrillæ, so that they must be used in breathing, although the general surface may be adapted to this function.

Fam. 4. *Plachobranchidæ.* Founded upon the single genus *Plachobranchus* of Van Hasselt. The body has broad lateral expansions used as swimming organs, and these, and also the back, are covered with branchial lamellæ. The expansions can be turned upwards, and their margins made to meet over the back. P. ocellatus, two inches long, was found at Java.

Order 5. Crypsibranchia (also known by the inadmissible name of *Tectibranchia*). The branchiæ are unsymmetrical, composed of leaves more or less divided, and they are covered by the upturned mantle. These animals are monoicous, and are comprised in the two families *Aplysiidæ* and *Bullidæ.*

Aplysia (*pl.* 77, *fig.* 18) was named *lepus marinus* by the ancient authors, and many fables entered into its history. The shape is not much unlike that of a naked snail, but the body is larger posteriorly. There are two pair of tentacles, the anterior ones being the largest, and of such a form (in connexion with that of the body) as to suggest the name of *sea hare* for the animal. The branchiæ are in a cavity protected by an operculum containing a thin corneous body, which is a rudimentary shell, and have their parietes composed of interlaced fibres; they are pierced with numerous small holes through which the blood may escape into the stomach, and the vascular system receive the liquid products of digestion.

The species of Aplysia are found upon the coasts of continents and islands at no great depth, some crawling upon rocks or hiding in their crevices; others hiding in the mud or sand, but with the branchial siphon exposed. Their food is marine plants or animals. The shell in the different species varies in texture, some approaching the solid shell of *Dolabella*, and the change is so gradual, that Rang, the chief authority upon these genera, considers the latter genus merely a section of Aplysia.

Fam. 2. *Bullidæ.* The chief genera of this family are the allied Bulla, with the shell external; and Bullæa with the shell internal. In *Bulla* (*B. physis*, *pl.* 76, *fig.* 3) the tentacles are wanting, the shell is thin in texture, subglobular, more or less completely enrolled, and having the aperture the entire length of the shell.

Order 6. Hypobranchia (also incorrectly named *Inferobranchia*). This order is named from the position of the branchiæ under the margin of the mantle. It contains three families, represented by the genera *Phyllidia*, *Pleurobranchus*, and *Umbrella.*

Fam. 1. *Phyllidiidæ.* *Diphyllidia* (*pl.* 74, *fig.* 19) is oblong oval, with a coriaceous rough integument, forming a prominent lateral border. The branchiæ surround the body, and are in the form of transverse lamellæ; there are four tentacles, two of which are superior and retractile.

Fam. 2. *Pleurobranchidæ.* In Pleurobranchus the branchiæ resemble a fringe formed of laminæ, on each side of a medial branch placed in a groove upon the right side between the mantle and foot. The animal is shaped

like a slug (Limax) or naked snail; and it has a small internal flat thin shell, and four tentacles.

Fam. 3. *Umbrellidæ.* This family is monoicous; the branchiæ are foliaceous, and disposed in a long line upon the right side. *Umbrella* has a discoidal, external, dorsal shell, bearing some resemblance to that of a very flat Patella; a very large foot, and four tentacles. Some authors consider this family as a distinct order under the name of Pomatobranchia.

ORDER 7. CYCLOBRANCHIA. In this order the branchiæ, as the name indicates, are arranged in a circle around the body above the foot. It contains the two families *Patellidæ* and *Chitonidæ*, both of which are monoicous, and have a long tongue armed with teeth. Blainville named this order *Cervicobranchia*, from an erroneous opinion that the organs generally received as branchiæ are merely membranous plaits without the function of branchiæ, which he supposed should be looked for in a sac above the neck.

Fam. 1. *Patellidæ.* The genus *Patella* (*pl.* 75, *figs.* 76, 77, 79) has a simple conical shell with an oval or circular base; inside with a submarginal cicatrix open in front. The shell covers the animal like an inverted cup. The animal is monoicous, creeping slowly upon a large foot, with which it can adhere with great tenacity to rocks. Some species seem not to move, except perhaps at long intervals, as they are found in depressions which they have formed in the rocks, and which correspond to the outline of the shell.

Fam. 2. *Chitonidæ.* The shell of *Chiton* (*pl.* 76, *fig.* 55) differs so much from that of Patella, that its position among the Mollusca was for a long time doubtful. An examination of the animals of both genera at length proved them to belong to allied families. The shell is oval, and divided transversely into eight pieces resting upon the back of the animal, with the lateral portions united by a coriaceous border. Thus constructed, the Chitons have the power of bending themselves together. The tentacles and eyes are wanting, but the former are replaced by a veil. Their habits are similar to those of Patella. In *Chitonellus* the animal is long and narrow, and the border of the shell extends so far upon the back that the dorsal plates are reduced to a small size.

ORDER 8. ASPIDOBRANCHIA (also incorrectly named *Scutibranchia*). In this order the shell is allied to that of Patella in form, but it is emarginate, or perforate. The order is divided into the two families *Fissurellidæ* and *Calyptræidæ*.

Fam. 1. *Fissurellidæ.* The shell of Fissurella, with the perforation through the apex, bears a distant resemblance to a key-hole scutcheon, and, excepting the perforation, resembles that of a Patella; but it is often too small to cover the animal. The perforation admits water to the branchiæ, and allows the fæcal matter to be excluded. There are two pectinated branchiæ in a cavity at the anterior part of the back; and two tentacles, with the eyes at their external base. *Fissurella græca* (*pl.* 75, *fig.* 80). *Emarginula* (*fig.* 82) differs from Fissurella in having the aperture which admits water to the branchiæ removed to the anterior margin of the

shell, where it forms a notch; and the apex of the shell is directed backwards, whilst in Fissurella it turns forwards.

Fam. 2. *Calyptræidæ.* The shell of Calyptræa is patelliform or trochiform, irregular, somewhat conical, with the apex rather posterior. Towards the apex of the inside there is a plate which is sometimes funnel-shaped, and sometimes like the vertical half of a funnel. In other species it forms a spiral, which approximates the sheil to that of the spirivalve genera. The animal is not spiral, the two tentacles are large and triangular, having the eyes upon an enlargement of the external side; the branchial cavity is large and oblique, and the branchiæ are pectinated, filamentous, and exsertile. *Calyptræa sinensis* (*pl.* 75, *fig.* 78).

Crepidula has an ovate or oblong shell, generally convex above, the internal cavity divided some distance by a shelly diaphragm which represents the plate in Calyptræa, and above which the viscera are placed. The animals of these two genera are alike, and the shells of some species present intermediate characters, so that it is difficult to tell to which of the two genera they should be referred. The Crepidulæ are sedentary, seating themselves upon stones, or upon each other, and adapting the margin of their shells to the irregularities of the object upon which they place themselves.

Order 9. Nematobranchia (or *Cirrhobranchia*). The genus *Dentalium* (*pl.* 75, *figs.* 73–75) was for a long time believed to belong to the Annellida, until dissection proved it to be a mollusc. The shell is a long, slender, and slightly curved cone, open at both ends, and sometimes ribbed or striate externally, as in *D. elephantinum* (*fig.* 73). The convex part of the shell corresponds to the back of the mollusc. The branchiæ are composed of numerous extensible filaments forming a bundle upon each side of the neck, and it is probable that the branchiæ can be used to convey food to the mouth. The vent is at the posterior or smaller end of the shell, the lips are scolloped into a number of palpiform projections, and the ordinary tentacles and eyes are absent. The animal lives vertically in the sand with the head downwards. There are some shells which closely resemble those of Dentalium, and which were classed with them until it was ascertained that their animal is an annellid. They form the genus Ditrupa.

Order 10. Ctenobranchia (also named *Pectinibranchia*). This is an extensive order of dioicous spirivalve mollusca, in which the branchiæ are pectinated, one or two in number, and placed in a large cavity above the neck; the tongue is armed with numerous teeth, the tentacles and eyes are usually two in number, and the aperture is usually closed by an operculum. Most of the families are marine, but some inhabit fresh water. The families are as follows: 1, Melaniidæ; 2, Cerithiidæ; 3, Vermetidæ; 4, Trochidæ; 5, Pyramidellidæ; 6, Buccinidæ; 7, Purpuridæ; 8, Strombidæ; 9, Conidæ; 10, Cypræidæ; 11, Volutidæ; 12, Sigaretidæ.

Fam. 1. *Melaniidæ.* Menke's corresponding family named *Turbinea* is inapplicable, because in its various modifications it is used for the family to which Turbo belongs, by Lamarck and Deshayes, and by Blainville for a family of Polythalamia. Some of the genera of this family inhabit the sea,

and others the fresh waters. The mantle is simple, without fringe or siphon; the head ends in a short trunk, and the food is vegetable, chiefly decaying algæ. The family contains a number of sub-families, the limits of which are not well ascertained. *Melania amarula* (*pl.* 75, *fig.* 90).

Littorina is a genus of small marine shells which inhabit the coasts. *L. tenebrosa*, which inhabits both sides of the North Atlantic, leaves the water for hours, climbing up the grass of the salt meadows. According to Dr. Gould, it may be found "at a considerable distance from any water." He remarks, also, that "it lives a week or more after being removed from the water." The species vary very much in their specific characters. Planaxis and Eulima are placed in this family, as well as Turritella (a shell much like *pl.* 75, *fig.* 117, but with the aperture entire), but as the mantle is stated to be scolloped, it seems to be more nearly allied to the Cerithiidæ. The mantle of *Scalaria* (*pl.* 75, *fig.* 101, *S. clathrus*; *fig.* 102, *S. scalaris*) not having been described, its place remains doubtful, although it probably comes near to Turritella.

Paludina is a genus of freshwater shells of a subglobular or conical form, usually covered with a greenish periostraca, and sometimes ornamented with bands, as in *pl.* 75, *fig.* 95, which represents the shell of *P. vivipara* of Europe and the United States, but the animal is incorrectly drawn, so as to resemble a land snail. The foot is a large, flat body, with the sides parallel, truncated in front and rounded behind; the tentacles subulate, not annulated, and bearing the eyes upon an enlargement of their external side. *Paludina decisa* is about half an inch long, of a fine green color, and is widely distributed in the United States. The animal is figured in the Freshwater Univalve Mollusca of the United States.

Amnicola resembles a minute Paludina in the form of the shell, but the operculum is subspiral, and not concentric as in that genus.

Valvata is a genus of small shells much like Amnicola, but the aperture is circular and the operculum concentric. The branchiæ are exserted, and in the form of a minute plume. An exserted organ like a single thread is supposed to be an accessory branchia.

Paludina, *Valvata*, and *Ampullaria*, from Lamarck's family *Peristomata*; and Cuvier and Swainson placed them under a division of which Turbo is the type.

Melania is the type of the sub-family Melaniinæ, which includes a number of genera, among which are Melania, Melanopsis, Pirena, and Anculosa. In Melania the shell is solid, turreted, with a greenish or blackish periostraca, the aperture elliptical, the external margin sharp, and the operculum corneous and subspiral. The species live upon calcareous rocks, or upon the ordinary bottom of the rivers, especially in those of the United States. The zoological characters of the genus are given in the American Journal of Science, 1841, vol. xli. p. 21.

Leptoxis (or *Anculosa*) is allied to Melania, but the shell is shorter. The animal attaches itself to rocks where the current is very rapid, and it seldom moves from its position. The history of this genus is given in Chenu's *Illustrations Conchyologiques*, where it is illustrated by 170 figures. The

genus seems to be confined to the rivers of North America. Rafinesque's generic name *Leptoxis* was published two years before Say's *Anculosa.* Some authors suppose the former to be a genus of Physidæ, but the question is settled by some manuscript drawings of the former author, which represent the shell, tentacles, and operculum of Anculosa.

Melanopsis is allied to Anculosa, and the species seem to be confined to Europe. It is probable that the few described species of European Melania belong in reality to Melanopsis.

Say's *Melania armigera* (and also Lea's *M. duttonana* and *M. Catenoides*), belongs to Rafinesque's genus *Pleurocera*, in which there is a short straight canal anteriorly, and when this canal is lengthened as in Fusus, the genus *Io* of Lea is the result. *Strepoma* of Rafinesque (or *Ceriphasia* of Swainson) are slightly different forms, in which the aperture and the vertical plane formed by the anterior portion of the whirls, bear some resemblance to the same parts in Cerithium telescopium.

Fusus fluvialis of Say is the type of *Io*, and as it would be an anomaly to find a genus so decidedly marine as Fusus inhabiting fresh waters, it becomes a matter of interest to know the animal of the American shell. This was observed in 1841, in its native waters in Holston, Powel's, and Clinch rivers, in eastern Tennessee, by Halderman, who made a drawing of the living animal. Its characters and habits are not those of Fesus, but of Melania proper, as distinguished from Leptoxis; for although it inhabits the rapids as well as quiet water, in both cases it avoids the current by seeking shelter beneath shelving rocks, or in hollows or crevices in them. The head is large, and with the tentacles much exposed; the foot is as large as in Melania; the coloration is the same (black lines upon an orange ground); the operculum is subspiral as in Melania, the mantle extends into the canal of the shell, but does not form a closed siphon; the vent is upon the right side; the mouth is a longitudinal slit; the eyes (which are sensitive to the light) are upon a short enlargement of the outer base of the tentacles, which may be a little longer than in Melania, and they are not visibly annulated. It differs from Fusus, and resembles Melania in living upon vegetable food; and it moves along in a sluggish manner, moving the head from side to side upon the bottom. *Io spinosa* and *I. tenebrosa* are merely varieties of *I. fluvialis.* The spinose individuals are much the most abundant, although the species is rare when compared with various species of Melania.

Quoy and Gaimard, to whom the science of Malacology is indebted for a knowledge of the animals of many shells, have figured a number of species as belonging to Melania, the shells of which cannot be distinguished from those of that genus, whilst in the figures the mantle is represented as scolloped. Similar species were drawn in the course of the United States Exploring Expedition. These species must be placed in the family Cerithiidæ.

Fam. 2. *Cerithiidæ.* The genus *Cerithium* (*pl.* 75, *figs.* 105–109) are remarkable for the great number of species both recent and fossil (tertiary) which it contains. The animal has the general character of Melania, except that the mantle is scolloped.

The number of species and varieties being so great in this genus, Lamarck was led to doubt the permanency of species, and he judged that those which seemed better established in other cases, would present equal uncertainty were their number greatly increased.

Fam. 3. *Vermetidæ.* The genus *Vermetus* (*V. lumbricalis*, *pl.* 75, *fig.* 69) has a loosely and irregularly coiled shell affixed by its posterior extremity. As the animal enlarges it increases the size of the shell, and moves forward in it, cutting off the empty posterior portion by a diaphragm from time to time. The animal is much like that of Turbo or Delphinula, the foot (as there is no locomotion) is obsolete, the posterior portion being adapted to support a thin operculum which closes the aperture. There are two tentacles, with the eyes at their base externally. There is a single branchia. Cuvier placed this genus, with Magilus and Siliquaria, in a distinct order named *Tubulibranchia.* In the genus *Magilus* the young has an ordinary short ventricose turbinated shell (having a distant resemblance to *pl.* 75, *fig.* 91). We have seen, in the case of *Aspergillum* (p. 60), how a bivalve shell can take the form of a tubular one; and Magilus is an example of the same thing in a spirivalve one. The animal inhabits cavities in living coral, and to prevent being buried by the growth of the surrounding material, it has the power of forming a tube, the margin of which it builds up as the coral increases, so that the aperture retains the level of the general surface. The tube thus attains five or six times the length of the original shell, and it assumes various curves and irregularities, depending upon the growth of the coral.

Fam. 4. *Trochidæ.* The members of this family are herbivorous, and most of them have the mantle or foot ornamented with tentacular appendages. The shell of Trochus is short and conical, solid, and nacreous. The genera *Trochus* (*T. solaris*, *pl.* 75, *fig.* 106; *T. magus*, *fig.* 107; *Turbo*, *fig.* 103) *Monodonto* and *Delphinula* (*D. delphinus*, *fig.* 104) are nearly allied, and the animals do not differ. In *Solarium* (*S. perspectivum*, *pl.* 75, *fig.* 108), the shell and animal differ, the head not being proboscidiform.

Janthina ianthina (*pl.* 75, *fig.* 96) is the type of a sub-family, distinguished by the possession of an apparatus which enables the animal to float at the surface of the sea. The name is derived from the Greek word for *violet*, the shells of all the species being of this color. The shell is trochoidal and very fragile, having the right side of the aperture sharp, and often notched. The animal has a large proboscidiform head, two tentacles, and eyes; the mantle with an expansion said to be used in swimming; the foot with an appendage or float formed of a great number of air-vesicles. This appendage can be cast off and renewed. The latter process was observed by Dr. Reynell Coates, who describes it as being formed by inclosing a bubble of air in a cavity formed by contracting the margin of the foot, which then secretes a covering for it. The eggs are attached to the under surface of the float, and subsequently cast off with it. This animal was first described and figured by Fabius Columna, in 1616.

In *Haliotis* (*H. tuberculata*, *pl.* 75, *fig.* 86), the shell is ear-shaped, much depressed, very short and flat, the aperture longer than wide, and as large as the base of the shell, left side with a sub-marginal row of perforations;

nacre very brilliant and iridescent. As the animal increases in size a new hole is formed in the shell, and the oldest one is closed. The head is proboscidiform, with two long tentacles, each with an oculiferous peduncle; foot large, provided above with a double membrane scolloped into leaflets of a very ornamental character. The water is admitted to the branchiæ through the holes in the shell, which also allow certain filamentous appendages of the mantle to protrude through them. There are two pectinated branchiæ. The genus *Stomatia* is allied to Haliotis, but the shell has no perforations. This sub-family was included by Cuvier among the Aspidobranchia, but Deshayes assigns good reasons for placing it among the Ctenobranchia.

Neritina (*N. fluviatilis*, *pl.* 75, *fig.* 87) is a genus of small sub-globular or oval fluviatile shells, with a semi-circular aperture closed by a calcareous operculum. The two tentacles are long, and each is accompanied by a short secondary tentacle, with an eye upon its summit.

Fam. 5. *Pyramidellidæ.* This is a small family, composed of the genera *Pyramidella* and *Tornatella.*

Fam. 6. *Buccinidæ.* In *Buccinum* (*B. undatum*, *pl.* 75, *fig.* 120), the foot is narrow, the head small, continued in a proboscis, with two tentacles, each having an exterior oculiferous peduncle; siphon protruding; sexes distinct, the male with a long exterior organ from the right side of the neck; shell oblong-oval, with a notch anteriorly. The species figured inhabits both sides of the North Atlantic. The genus has numerous species, both recent and fossil. Nassa and Eburna belong to this family. *Eburna glabrata* is an Ancillaria, and Deshayes thinks the remaining species of Eburna should be merged into Buccinum.

Fam. 7. *Purpuridæ.* This marine family is mostly carnivorous; the water is taken to the branchiæ through a siphon, which passes out of the notch or canal at the anterior part of the shell. The eyes and tentacles are two in number, and the proboscis is well developed. The operculum is thin, and much smaller than the aperture, to allow the animal to withdraw some distance within the shell. *Cancellaria* is placed in this family, although it has no operculum, and lives upon vegetable food. The animal resembles Purpura.

Purpura lapillus (*pl.* 75, *fig.* 118) is about an inch long, and abundant on rocky coasts on both sides of the Atlantic.

Pleurotoma (*P. babylonia*, *pl.* 75, *fig.* 110) is a genus with an elongated spire, a straight canal, and a narrow notch posteriorly in the right lip of the shell, corresponding to a notch in the mantle. The species of this genus are numerous, amounting to over a hundred of recent, and more than this number of fossil tertiary species. There have been nearly fifty species described from the tertiary formations of the United States.

Murex (*M. ramosa*, *pl.* 75, *fig.* 111; *M. haustellum*, *fig.* 112; *M. tribulus*, *fig.* 113). Rondeletius and Aldrovandi have treated of this and some allied genera. The genus *murex* of Linnæus was founded in 1758, but Rondeletius had named several of the species *purpura*, under the belief of their being the *purpuræ* of Pliny, which were supposed to furnish the purple of the Tyrians. The shell named *Murex* by Pliny and Rondeletius, belongs to the modern genus *Strombus.* Murex is a genus of

rough shells, with ridges, spines, or tubercles, which are secreted periodically, in three or four rows around the shell. The right margin of the mantle is divided into lobes, the irregularities of which account for those of the shell in the different species. There are about 170 recent and 130 tertiary fossil species known.

Harpa (*H. ventricosa*, *pl.* 75, *fig.* 119) is a genus of finely formed ribbed shells of brilliant colors, and a polished exterior. The foot is very large, and without an operculum. Ten species are described in Lamarck. The genus occurs fossil in the Paris basin.

Cassidaria (*C. echinophora*, *pl.* 75, *fig.* 121). This genus contains a few recent and fossil species. The animal is like that of Cassis, in which the foot is longer than the shell, the head proboscidiform, with a projecting rostrum and mouth from its extremity.

Fusus is a genus of marine shells, thickest in the middle, and tapering towards both ends; the animal with a small head, ending in two short tentacles, the eyes at their external base, but not upon a peduncle or thickening of the tentacle, thus differing from Murex and Purpura, but allied to Turbinella and Fasciolaria. The head has a terminal slit, whence the rostrum issues, and the nucleus of the operculum is terminal.

Fam. 8. *Strombidæ.* In this family the right margin of the aperture is dilated, corresponding to the width of the mantle, but this character is not present in the immature shells, so that a young *Strombus* (*pl.* 75, *fig.* 114) might be mistaken for a *Conus* (*pl.* 76, *fig.* 11). The head is proboscidiform, with a vertical slit from which a long rostrum is extended; the tentacles are large, divided at the end, and the truncated extremity of the larger external branch bears the large eyes, which have a variously colored iris and a cornea, which have not been observed in any of the allied families. They live on coral banks at no great depth, and some species attain to a considerable size. The locomotion differs from that of most gastropoda, being effected by leaping, for which purpose the operculum (which has a peculiar shape) is applied to the ground. *Strombus lentiginosus* (*pl.* 75, *fig.* 114). *S. gigas* of the Antilles is eight or ten inches long, and remarkable for the fine peach blossom tint of the aperture. The shell is used to ornament grottoes and gardens, and by sawing off the apex it is converted into a rude trumpet. *Pterocera* (*P. chiragra*, *pl.* 75, *fig.* 115) differs from Strombus in having the adult shell digitated, and the structure of the mantle corresponding with it. *Rostellaria* (*R. rectirostris*, *fig.* 116).

Fam. 9. *Conidæ.* The shell of the genus *Conus* (*pl.* 76, *figs.* 8–12) is obconical, involute, and has a short spire and a narrow aperture as long as the body whirl; and the exterior is covered with a periostraca. The genus includes many beautiful and highly prized species. Linnæus described 35 species, Bruguières 146, Lamarck 181, increased to 219 in the last edition of 1845, exclusive of 23 European fossil species. At present there are probably 300 recent species known. The head is proboscidiform, the eyes are upon the middle of the tentacles, the foot is long and very narrow, having a corneous sub-spiral operculum, so small in comparison with the aperture, that it cannot serve to close the shell. The mantle is scanty (in

which it differs from the next family), and prolonged in a siphon, which extends a little beyond the shell. The animal is carnivorous, and the tongue is armed with hooked teeth.

Fam. 10. *Cypræidæ* (or *Involuta*). In this family there is neither operculum nor periostraca, the shell is rolled upon itself nearly as in Conus, but some are rolled upon a cylindrical instead of a conical axis, so that there is no spire exposed. The shells are very beautiful and highly polished, the mantle being so wide that its sides can be turned over the back of the shell, where it secretes the ornamental layer of the shell. The point of union of the margins of the mantle is often indicated by a discolored line upon the back of the shell.

Cypræa (*C. moneta*, *pl.* 76, *fig.* 5; *C. mauritiana*, *fig.* 6; *C. arabica*, *fig.* 7), has the mantle edged with tentacular filaments, and when they are turned over the back, the shell is hidden. The aperture is long and narrow, each side denticulated, and the external margin turned in. C. moneta is used as money in western Africa.

Ovula (*O. ovum*, *pl.* 76, *fig.* 4; *O. volva*, *fig.* 2), as the name indicates, is shaped somewhat like an egg, with the ends attenuated, and the inner margin of the aperture without denticulations. The animal resembles that of Cypræa.

Oliva (*O. ispidula*, *pl.* 75, *fig.* 122; *O. porphyria*, *fig.* 125; *O. maura*, *fig.* 126) has the head very small, and the tentacles united at the base. These resemble somewhat the same organs in Strombus, being divided, and having a terminal eye upon one of the branches. O. porphyria is the largest and handsomest species of the genus, being four or more inches long, of a pale brownish purple, marked with numerous zigzag angular lines, and having the anterior extremity violet. It inhabits the coast of South America.

Fam. 11. *Volutidæ*. In this carnivorous family there are usually distinct folds upon the columella. *Voluta* is a genus of large and handsome, generally inoperculate shells, with a wide aperture notched in front, and the apex rounded. A part of the shell has sometimes the appearance of being varnished, which indicates the extent to which it is covered by the mantle. The animal cannot entirely enter the shell, the head is proboscidiform, and the tentacles are short, with the eyes at their external base.

Mitra (*M. episcopalis*, *pl.* 75, *fig.* 123; *M. papalis*, *fig.* 124) is a genus of handsome shells extremely rich in species, there being about 250 recent and 100 fossil species known. The animal is very dull in its movements, the head small and V-shaped, on account of the projection of the slender tentacles. These have the eyes upon an external peduncle. In Mitra episcopalis (shell white with red spots), the rostrum is once and a half times the length of the shell, exceeding that of any other genus. This enables it to attack its prey at some distance.

Terebra (*T. maculata*, *pl.* 75, *fig.* 117) has the foot (which bears an operculum) but little longer than the last whirl of the shell, a proboscidiform head, tentacles and eyes in the usual form, and the siphon projecting beyond the shell. There are upwards of a hundred recent species known.

Fam. 12. *Sigaretidæ*. *Sigaretus* (*S. haliotideus*, *pl.* 75, *fig.* 89) is a

genus in which the shell is somewhat ear-shaped, and the foot very large and thick, nearly hiding the shell, which is sunk into it. The tentacles are flat and triangular, but unaccompanied by eyes. Although the animal is too large to enter the shell, it is provided with an operculum. *Natica* (*N. canrena*, *pl.* 75, *fig.* 88) is carnivorous like the preceding genus, and like it, has no siphon. It has a large foot (four or five times the length of the shell) bearing an operculum. The head is terminated by a pair of lips from which a rostrum can be protruded.

ORDER 11. PNEUMONOBRANCHIA. This order includes all the spirivalve and naked mollusca, whether inhabiting land or water, in which the branchiæ, without being proper lungs, are adapted for breathing air, so that the species which inhabit the water are obliged to come to the surface from time to time to breathe air. They seem all to be phytophagous. The order includes eight families.

Fam. 1. *Ampullariidæ.* The genus *Ampullaria* has a globular shell several inches in size, which is generally covered with a green periostraca, and is provided with a closely fitting concentric operculum, which is in some cases corneous, and in others shelly. With Paludina and Valvata it forms one of Lamarck's families, named *Peristomata* by Reeve. The North American species is figured with the animal in the monograph already quoted. The head is proboscidiform, the extremity cleft, leaving a conical branch half an inch long on each side, and these are used as palpi. The mouth is purse-shaped, the tentacles slender, tapering, and more than an inch long, the eyes borne upon a secondary tubercle at the base externally. The shell is without a notch, yet there is a siphon an inch long which is formed by an extension of the mantle folded into a tube. This is brought to the surface of the water and air drawn through it, and often expelled from it in bubbles when beneath the surface. Guilding describes a shorter siphon upon the right side. The animal lives in the rice swamps of Georgia, feeding upon living plants. Living mostly in the intertropical regions of both hemispheres, where the waters frequently disappear in the dry season, Ampullaria has the power of becoming torpid beneath the mud until the return of the wet season. Some specimens sent from Egypt to France were thrown into water to clean them, and the next day they were found moving about. Deshayes dissected some of these, and found pectinated branchiæ, which would place the genus near Paludina, and he describes a large cavity, to which he assigns the function of holding a store of water to be supplied to the branchiæ during the period of torpidity. This may be correct; although a further examination will probably show that this cavity is adapted to breathe air, and on this account we place it in the present order. *Planorbis bicarinatus* (and probably its entire family) hybernates at the bottom of streams with the air cavity filled. The ability to breathe air and water by means of distinct organs is not anomalous, as it appears in certain reptiles. The sexes are separate.

Fam. 2. *Amphibolidæ.* The genus *Amphibola* (also named *Ampullacera*) has a sub-spiral corneous operculum, and is formed upon a New Zealand shell formerly considered to be an Ampullaria. It was found to breathe air

by Quoy and Gaimard, who found it abundantly in very shallow brackish water. It has a large head ending in two lobes, is without tentacles, and the eyes are placed flat upon the head. The pulmonary cavity is large, in which it resembles that of Ampullaria. The sexes are united in the same individual. Two species are known, *A. avellana* and *A. fragilis*.

Fam. 3. *Cyclostomidæ.* The genus *Cyclostoma* is monoicous; it has a turbinated shell with a circular aperture, and, unlike most land snails, it has a paucispiral operculum. The head is probosciditorm, the tentacles two, with the eyes at their external base; and the foot is composed of two longitudinal parts which are advanced alternately. Other species have a concentric operculum, and in these the foot has the ordinary construction. Cuvier and Deshayes consider the mode of respiration less important than the general structure, and they are consequently of the opinion that the affinities of this family are with the Trochidæ. The species are numerous, amounting to nearly 200.

Helicina may be considered the type of a sub-family. It has an oblique aperture, and a closely fitting operculum which is not sub-spiral, but increases from one of the sides or angles.

Fam. 4. *Physidæ.* This family is composed of certain genera of inoperculate fragile uniformly colored shells, inhabiting quiet fresh waters, coming to the surface to breathe, and creeping along it with the back downwards by means of the vibrillæ which cover the foot as well as the two tentacles and other parts. Many eggs are deposited together in a glairy mass. The breathing aperture is at the external side, and is opened from time to time to take in a supply of air. In *Physa* the shell is turbinated, sinistral, the mantle large, with a digitated margin turned upon the shell, and the foot long and pointed posteriorly. The tentacles are filiform, and the eyes are situated upon the head near their internal base. *Planorbis* (*pl.* 77, *fig.* 99) has a discoidal shell, with the turns visible on both sides. The mantle is simple, the foot rather small, and the tentacles and eyes as in Physa. In *Limnea* (*L. stagnalis*, *pl.* 75, *fig.* 92), the shell is dextral, turbinated, and generally larger than in the allied genera; the tentacles are triangular, and the eyes situated at their anterior base. *Ancylus* is a genus of little patelliform shells, the position of which in the systems has been a subject of much dispute, some contending that they belong here, and others to the Hypobranchia. The animal is not essentially different from Limnea, and it is possible that some species breathe air, and others water. Some authors have asserted that they come to the surface to breathe air, but this has never been observed in the American species, some of which are found beneath stones, in dead bivalve shells, and under other circumstances, which would render it difficult for them to reach the surface and descend again. But as free air may not be considered necessary to these animals, they may be placed among the Physadæ, especially as a species of Physa inhabiting beneath shelving rocks in rapid water is found at the mouth of the Nolachucky river, Tennessee, in such a position that it could not breathe air. It is probable that a small variety of Physa heterostropha inhabiting springs seldom or never breathes air. It has been ascertained that frogs kept under water can oxygenate the system through the skin, and the

Physadæ may have the same power. The passage to the next family seems to be through Gray's genus *Chilina*, which is a Limnea with folds upon the columella.

Fam. 6. *Auriculidæ.* In this monoicous family there are two tentacles, and the eyes are at their external and posterior base. Some species inhabit land, and others plants near the sea, and salt water marshes. *Auricula midæ* (*pl.* 76, *fig.* 1) is the largest species of the genus, being four inches long, and of a solid texture.

Fam. 7. *Helicidæ.* This family includes most of the numerous species of land snails with an external spirivalve shell. All breathe free air, are monoicous and inoperculate, and have two large tentacles, with an eye upon the apex, capable of being retracted by being turned within itself. Besides these, there is an inferior and smaller pair of tentacles present in most cases, although in some of the minute species they have not been detected. Most of the land shells of Europe and North America belong to *Helix*, a very extensive genus, containing upwards of 500 species from various parts of the globe, including the islands of the Pacific, all the continents, high mountains, and cold climates, although the larger species are intertropical. They vary in size from about a tenth of an inch to four inches. The shells vary much in form; the aperture is sometimes reduced to a narrow fissure, or armed with teeth, in such a manner as to lead one to think it impossible for the animal to get out or in. They hybernate under ground, closing the aperture with a temporary operculum. Among the genera may be mentioned *Bulimus* (*pl.* 75, *figs.* 93, 94), *Clausilia* (*fig.* 100), which has a peculiar operculum attached to the shell within the aperture, *Pupa*, *Streptaxis*, &c. Their food is fresh or decaying vegetable matter, and some feed upon fungi. The large European species are cooked and eaten, and the Romans fattened them for the table.

Fam. 8. *Limacidæ.* This family includes the naked snails without a turbinated shell, but some of them have an internal shell, or a small external one which is little more than an appendage. The head, tentacles, organization, habits, and food, do not differ essentially from those of the preceding family. The genus *Limax* (*pl.* 77, *figs.* 19–21) is destructive to the plants cultivated by the farmer and gardener in Europe, and new modes of destroying them are continually sought after. The species which occur in North America have not yet proved injurious, and the same remark applies to the snails, which are troublesome to gardeners in Europe. The body of Limax is very contractile, but when moving on its lower surface or foot, it is rather slender, thickest in the middle, and tapering towards the extremity. Upon the back is a kind of fleshy shield, beneath which the head can be drawn.

Class 3. *Cephalopoda.*

This class was named *Malakia* by Aristotle, and *Mollia* by Pliny. It includes certain dioicous marine mollusca, which have the feet or arms around the mouth at the extremity of the head. The body is soft, the

mantle closed beneath according to most authors, but above according to Rang. Most of them have three hearts. The mouth is armed with strong mandibles much like those of a parrot, adapted for crushing the shells of crustacea and mollusca, and the tongue is armed with pointed horny teeth. The eyes are either pedunculated or level with the surface, and they have the sense of vision fully developed. They have also an organ of hearing. The arms are usually cotyligerous, or studded with suckers like cupping glasses, which enable them to hold fish and other living prey. The Greeks, in naming these sucking cups, made use of the word *kotylus* (in composition), whence the English name *cuttle-fish* is derived. The cotyls are sometimes armed within with curved hooks, which assist in holding and destroying the prey. Onychoteuthis has a pair of arms much longer than the rest, the terminal expansion of which is studded with rows of hooks, but the power is increased by a simple sucker on each wrist (as it may be called), which are applied together to keep the extremities of the arms in contact.

There is a fleshy infundibulum or funnel opening before the neck, and serving as an outlet for the fæces and water from the branchiæ. The water ejected from the branchial sac through the funnel is a principal agent in locomotion, by means of which the animal can move backwards with great swiftness. Inspiration and expiration are regular in these animals. "The first is effected," says Dr. Coldstream, "by a gradual dilatation of the sac in every direction, but particularly at the sides, accompanied by a subsidence of the lateral valves, collapse of the walls of the funnel, and a rush of water through the lateral openings into the sac. Inspiration being completed, the lateral valves are closed, the sac is gradually contracted, the funnel erected and dilated, and the water expelled through it with great force in a continuous stream." An *Octopus* with a sac four inches long was found to respire ten times in a minute.

The Cephalopoda are either naked, or provided with an external shell. Some of the former are brilliantly colored, red, purple, or bluish, and they are remarkable for the rapidity and extent to which the colors change. In habits they are rapacious and active, moving continually, and some of them shoot through the water like an arrow.

Agassiz thinks that in this order the Nautilidæ are the lowest, and Sepiadæ the highest. We will here follow the classification of D'Orbigny, according to which the class is divided into two orders, *Acetabulifera* and *Tentaculifera*, the former being subdivided into two tribes, *Octopoda* and *Decapoda*,* containing seven families conjointly. As the name implies, the Acetabulifera are provided with cotyls, and the head is distinct, characters which do not exist in the Tentaculifera; and the former have two, and the latter four branchiæ, whence Owen's names of *Dibranchiata* and *Tetrabranchiata*.

Tribe Octocera.

Fam. 1. *Octopidæ.* The genus *Octopus* (*O. octopodius*, Linn. (*Sepia*) *pl.* 76, *fig.* 75) is the *polypus* of the ancients, whence the French name *poulpe*

* A name pre-occupied among the Crustacea, and on this account we employ the terms *Octocera* and *Decacera*, usually attributed to Blainville.

is derived. The body is obtuse posteriorly, with fins (fin-like expansions), and the interior dorsal shell is wanting. As the name implies, it has eight arms. The species figured attains a length of two feet and a half, including the arms, which constitute considerably the longest portion. It creeps upon the ground with the mouth downwards, drawing itself along by means of the circle of arms; or leaving the bottom, it swims backwards by flapping the fleshy disk from which the arms arise. It is provided with an ink bag. The eyes can be covered with the surrounding skin, in the manner of an eyelid. There are two complicated branchiæ somewhat like a fern leaf, through which the blood is forced, by a heart at the base of each; a third heart, near the bottom of the cavity, receives the oxygenated blood, and distributes it through the body. It is eaten on the shores of the Mediterranean.

Argonauta (*A. argo*, Linn., *pl.* 76, *fig.* 17), six or seven inches long, has a closely rolled involuted shell without partitions, laterally compressed, tuberculate, very thin, white, translucent, with the last turn including the rest. This is the *Nautilus* of the ancient authors, who were acquainted with *A. argo*, the Mediterranean species, about the sailing of which so many fables have been related, as in the following lines from the "Pelican Island."

> "Light as a flake of foam upon the wind,
> Keel upwards from the deep emerged a shell,
> Shaped like the moon ere half her horn is filled;
> Fraught with young life, it righted as it rose,
> And moved at will along the yielding water.
> The native pilot of this little bark,
> Put out a tier of oars on either side,
> Spread to the wafting breeze a twofold sail,
> And mounted up and glided down the billow
> In happy freedom, pleased to feel the air,
> And wander in the luxury of light."

For a long time naturalists considered the maker of the shell of Argonauta to be unknown, believing the inhabitant found in it to be a parasite, like the crabs which take possession of the empty shells of the spirivalve mollusca; and they were led to this belief, by the fact that there is no muscular attachment between the animal and the shell, presenting a peculiarity which is unique among the mollusca. The animal has eight arms, two of which have wide expansions at the extremity, which are applied one to each side of the shell, which is in fact secreted by their internal surface; and should it be intentionally broken, the damage is repaired by the same organs in ten or twelve days, a proof that the shell belongs to no other animal. It creeps upon the bottom with the shell above, or shoots through the water backwards by means of the funnel, with the narrow part of the shell in advance, and the arms extended like a rudder. When it retires within the shell, the expansions of the clasping arms are partly withdrawn, leaving a little of the anterior portion of the shell uncovered; consequently, they are never extended as sails, as many fabulous accounts would lead us to believe. See the Mag. Nat. Hist., 1839, pp. 421 and 521; 1840, pp. 8 and 57.

Tribe Decacera.

Fam. 2. *Sepiidæ.* *Sepia* (*pl.* 76, *fig.* 77) has the body surrounded by a narrow fin; and of the ten arms, two are pedunculated and longer than the rest. A light friable oblong-oval and spongy shell, usually named "cuttle-bone," is contained within the back. The contents of the ink-bag in this animal are dried and used by painters under the name of *sepia.*

Fam. 3. *Loligidæ.* *Loligo* (*L. loligo*, Linn., *pl.* 76, *fig.* 76) has the body slender, with lateral fins, the shell thin, horny, and translucent; two pedunculated arms longer than the rest, and the eyes are without a lid, but covered with a transparent membrane. Its motion backwards through the water by means of its funnel, is extremely rapid, and it sometimes throws itself out of the water, or upon land. The species are much used for food, especially in China.

Fam. 4. *Loligopsidæ.* *Loligopsis* has a slow motion, the shell is corneous, the body slender and translucent, and has few muscles.

Fam. 5. *Teuthididæ.* *Onychoteuthis* (already referred to) has a corneous internal shell, a slender body, with a triangular fin upon each side posteriorly, uniting upon the back.

Fam. 6. *Belemnitidæ.* Shell corneous, conical, largest anteriorly, and containing a series of chambers, posteriorly pierced by a siphuncle, and inserted in a hard case or *belemnon*, which is generally pointed posteriorly. The family is extinct, but its remains are abundant in a fossil state in the oolitic and cretaceous formations.

Fam. 7. *Spirulidæ.* The genus *Spirula* (*S. spirula*, *pl.* 76, *fig.* 13) is the only one in the family, and until recently it contained but a single described species. The shell is a thin open spiral (not twisted longitudinally as represented in the figure), with numerous partitions concave externally, through which a small ventral siphuncle runs. The shell is internal, at the posterior extremity of the body. There are ten arms, of which two are larger than the rest. The common species inhabits the Atlantic and Pacific Oceans, and although the shell is common, the animal is very rare, and requires further examination.

The second order, *Tentaculifera*, contains two families: *Nautilidæ*, and *Ammonitidæ*.

Fam. 1. *Nautilidæ.* In the genus *Nautilus* (*N. pompilius*, Linn., *pl.* 76, *fig.* 16), the shell is spiral, many-chambered, the partitions transverse, concave externally, their margins simple; a central siphuncle passing through them; the whirls in contact, the last enveloping the preceding ones. Nautilus pompilius is the best known species; the shell is nacreous, ornamented with irregular reddish bands, the umbilicus closed. It is six or eight inches in diameter, and inhabits the Indian and Pacific Oceans. A second species is known, *N. umbilicatus*, which is much rarer than the former, and has the centre of each side widely umbilicate, so that the whirls can be counted. The history of the order is taken from *N. pompilius.* The animal is contained in the last open chamber of the shell; it has a pediform appendage for creeping, and when it walks upon the bottom, the aperture is downwards. The jaws are like a reversed parrot

bill, the mouth is surrounded with numerous tentacles retractile into separate sheaths, and disposed in eight groups corresponding to the arms of Octopus. They are surrounded by a kind of hood, which serves to protect the animal when withdrawn into the shell. The two eyes are large and prominent, the heart single, with a ventricle and auricle, and inclosed in a large pericardium which is connected with the siphuncle. The siphon or funnel, which is ventral, corresponds to the part of the shell furthest from the centre, that is, the external lip. The fossils named *rhyncholites*, are the beaks of various species of *Nautilus* and *Ammonites*. Several other genera, with the shell both curved and straight, belong to this family, and among the latter is the fossil genus *Orthoceras*, of Breyn (not of Lamarck), of the older formations.

Fam. 2. *Ammonitidæ* (*pl.* 76, *figs.* 14, 15). In this family the shell is spiral in the same plane, curved, or straight, with the siphuncle at the dorsal margin. The partitions which divide its chambers are irregular, with the margins digitated or foliated, often in a singular and beautiful manner. All the species are extinct, and they are found from the older fossiliferous formations to the cretaceous strata. This and the preceding family are represented at the present day by the two living species of *Nautilus*, and four of *Spirula*, a mere remnant of the profusion of species of chambered shells which lived in the ancient seas. Upwards of 300 species of the genus *Ammonites* have been described or indicated; and although it is probable that many of these belong to varieties and young individuals, with every allowance, the genus is very extensive.

Division III. Articulata.

The *Articulata* are named from having the various parts of the body and limbs articulated to each other. The nervous system is composed of ganglions united by a double cord, and there is usually a kind of exterior skeleton composed of a series of rings protecting the interior parts, and serving as points of attachment for muscles. In some cases respiration is effected by means of branchiæ, and in others by tracheæ or air tubes. When limbs are present, there are never fewer than six.

Authors upon the Articulata are not agreed upon the number and extent of the classes into which they should be distributed, but they will be treated of in detail, nearly as they are given in pages 11, 12, according to which the classes are five, namely 1, *Annelida*; 2, *Cirrhopoda*; 3, *Crustacea*; 4, *Arachnida*; 5, *Insecta*. The three last of these formed the *Insecta* of Linnæus, a term which some modern writers wish to maintain according to its original extent; and when this is done, the restricted class of insects must have a distinct name; as *Ptilota* (winged insects), applied by Aristotle, and *Condylopa*, applied by Latreille. The Myriapoda will form the fifth, and the Insecta the sixth class, in the succeeding pages.

Class 1. *Annelida.*

The *Annelida* or *Chætopoda* are generally recognisable by a soft body, a lengthened annulated form, red blood, and the nervous system central, ganglionic, and distinct. The rings of the body are of a membranous consistency, and never corneous as in insects, or calcareous as in the Crustacea. They are generally numerous, the length of the animal depending to some extent upon the number of rings, which vary from twenty or thirty to more than five hundred. When very numerous, the number is not uniform in the same species. The head is usually distinct, and often provided with two or four eyes, and in some cases with a variable number of tentacles and cirri, but the last are not confined to the head. The sides are generally furnished with bunches of bristles and fleshy projections arranged in a line and used in locomotion; and although they are called feet, articulate limbs are never present. The lateral bristles in some cases afford a means of defence, and they vary much in character, some being simple, and others barbed in a variety of ways, presenting uniform characters which are useful in classification, and must be studied by those who wish to be well acquainted with the class. Their forms have been classified and named by Savigny. The alimentary canal is complete, extending from end to end. Most of the annelida are marine, some being free, whilst others construct a tube of calcareous matter, and of agglutinated particles of sand, fragments of shells, or other objects. Cuvier divides the class into three orders, named Abranchia, Dorsibranchia, and Tubicolæ; but as the names of orders should be taken from the same part, the last one is here replaced by the term Cephalobranchia.*

Order 1. Abranchia. The animals of this order are without branchiæ, respiration being effected by means of the skin. Cuvier supposed certain lateral pores to be respiratory orifices, but these have been ascertained to be the outlets of the organs which supply the mucus. The order includes the four families: *Hirudinidæ* (leeches); *Lumbricidæ* (earth-worms); *Echiuri*; and *Maldaniæ*.

Fam. 1. *Hirudinidæ.* This family includes the worms known as leeches, of which there are various genera, both marine and freshwater. The body is slimy and extensible, narrowing towards each end, composed of from 18 to 140 segments. Some species are cylindrical, and others flattened, and the posterior extremity has a disciform sucker to enable the animal to adhere. In some cases the mouth is surrounded with a sucker also, and in these, besides swimming, locomotion is effected by extending the body, fastening the anterior extremity, and then drawing up the posterior one. The eye-like points vary in number from two to ten. The species feed upon blood or the juices of animal matter. Some have teeth to puncture the integument, but others, not being thus armed, attack only the softer kinds of food, as worms, larvæ, or mollusca; and some swallow worms entire.

* Some authors use the final syllable *a*, and some *ata*, in words like these, and as either form is correct, the shortest one may be deemed the best.

A species of leech finds its way under the eyelids, and into the nasal passages of *Ardea virescens*, in Martinique. In Algeria, *Hæmopis vorax* is abundant, and attacks man and animals upon land; and it is found sticking to the inside of the mouth and throat of slaughtered cattle in that country. According to Baron Larrey, the French soldiers were much plagued by a small species which attached itself to the entrance of the throat. The same species was found in the nasal passages of the horse.

As it is difficult for a leech to affix itself to an animal, except at rare intervals, it has been provided with peculiar digestive organs to enable it to undergo a long fast. The stomach is formed of a number of cells, each of which has a lateral sac upon each side. The entrance from the stomach to the intestine has a valve, and at the posterior extremity of the intestine there is a sphincter to close it, so that the food may be admitted and retained in small portions as it is required, and it is a remarkable fact, that the blood thus kept in store (which may amount to nearly half an ounce) retains its natural properties for many months. Hence the difficulty of employing leeches in medicine when they have been gorged within some months. This difficulty is obviated in some degree, by forcing them to disgorge a part of the blood by pressure, and a mode has been discovered by piercing them with a lancet one third the length from the head, and placing them in tepid water, when the contents of the stomach will escape, especially if assisted by pressure. The wound heals in a few days, and the leech may be applied again in fifteen or eighteen days.

These animals are monoicous and oviparous, the eggs being deposited in a kind of cocoon, resembling in size and form that of the silkworm, its material resembling fine sponge. A Swedish species deposits its eggs in the earth at some distance from the water.

Among the genera are *Hirudo* (*H. officinalis*, *pl.* 77, *fig.* 26), *Malacobdella* (*M. grossa*, *fig.* 22), referred to in page 43; *Clepsina* (*fig.* 24), *Hæmopis* (*H. vorax*, *fig.* 25). Two species of leech are almost exclusively used in medicine: *Hirudo officinalis*, the green or Hungarian leech, the belly of which is without spots; and *H. medicinalis*, the German or brown leech, with a spotted belly.

The mouth of those leeches which are capable of biting, is tri-radiated, each ray having a tooth which resembles a segment of a minute circular saw, the margin of which is armed with a double row of microscopic denticulations. The suction, whilst it draws the skin within the reach of the teeth, renders it tense, so that they act like lancets, and the apparatus answers the double purpose of a small scarificator and cupping-glass. An examination of the wound made by a leech will show the tri-radiated arrangement of the teeth. Artificial leeches are sometimes made use of, the quality of which must greatly depend upon the accuracy with which the natural instrument is imitated.

Three species of Hirudo, and one of Clepsina, have been described from the waters of the United States.

It was at one time believed that changes in the weather might be foretold from the actions of leeches, but the value of these indications was

much overrated. They have been made to fast two or three years; they require five years to become large enough for use, and they may live twenty years. They seem not to multiply rapidly when they have not access to blood; and on this account, cows and horses are driven into the breeding ponds, and so frequently, that they become emaciated from the loss of blood. Three millions of leeches are used annually in Paris; and four dealers in London import upwards of seven millions annually. In 1819, five or six millions were used in Paris, at a cost of 120,000 francs; and in 1827, thirty-three millions were required in France. To preserve them in health, they must have clay, sticks, &c., to crawl amongst, to assist them in casting the skin, this part being often renewed: and if the old surface is not removed, respiration is interfered with.

Gervais, who insists upon the identity of the Annelida and Entozoa, places the family which includes Sipunculus (p. 42) next to the Hirudinidæ.

Fam. 2. *Lumbricidæ.* The genus *Lumbricus* (*pl.* 77, *figs.* 38, 44) contains the earth-worms, known by their habits of living in the earth, and coming to the surface in wet weather and at night. The body is reddish or bluish, cylindrical, composed of many rings, the head indistinct, the mouth without teeth, and having neither eyes nor tentacles. The segments are provided beneath with minute bristles, and above with one or two pores. At certain periods, in some of the species, the part of the body containing the reproductive organs has a broad collar named the clitellum.

These worms are monoicous, they feed upon the organic matter contained in the soil, generally ejecting the indigestible portion at the surface of the ground. Some species live in the soft mud at the bottom of streams, and the ordinary species may be kept in vessels of mud and water. The largest European species is a foot and a half long, but there are several exotic species several feet in length.

Earth-worms are very useful to the soil, as their perforations open it and allow the air and moisture to penetrate. They also assist in ameliorating it, and in increasing its depth; and where they are abundant, it is probable that every inch of soil has passed through their digestive system. In old unploughed pastures the soil formed by their castings is known to have amounted to an inch in depth in five years.

Nais (*pl.* 77, *figs.* 9, 10), which belongs to this family, has the segments with lateral spines or fascicles. The old genus thus named by Müller, has been subdivided by more recent writers. They inhabit the fresh waters.

Tubifex is a genus of microscopic worms found in fresh water, where they form a tube in the mud, whence they project the greater part of the body, waving it about, but instantly withdrawing when disturbed. Several species of the United States have been described.

Fam. 3. *Echiuri.* These have been alluded to in page 42. The body is short, composed of but few indistinct articulations, cylindrical, sacciform, provided with pairs of retractile bristles upon some of the segments. *Thalassema echiurus*, of the European seas, is the best known species.

Fam. 4. *Maldaniæ.* This is one of the families of the distinguished naturalist Savigny, who accompanied the French expedition to Egypt. In

the genus *Clymene*, the body is long and cylindrical, the extremities abrupt, the segments few and dissimilar, the head distinct, the thoracic portion long, and the abdomen short. The thoracic feet have two branches. It forms a tube with small shells and sand.

Order 2. Dorsibranchia. Here the organs of motion, and especially those of respiration, are arranged in linear series, either from end to end, or at the middle portion of the body. The head and eyes are usually distinct, and there are antennæ, jaws, and an extensible rostrum. The families are arranged by Audouin and Milne Edwards as follows: 1, *Aphroditidæ;* 2, *Amphinomidæ;* 3, *Eunicidæ;* 4, *Nereidæ;* 5. *Ariciidæ;* 6. *Peripatidæ;* 7, *Chetopteridæ;* 8, *Arenicolidæ.*

Fam. 1. *Aphromitidæ.* Body generally depressed, and shorter and wider than in the other annelida. Back with two rows of large membranaceous scales or elytra (except in the genus *Palmyra*), beneath which are the branchiæ, which are not well developed. Two pairs of jaws are generally present, and the elytra and superior cirri are alternately present and absent upon the segments to a certain extent. *Aphrodite* has thirteen pairs of elytra, three antennæ. The jaws are cartilaginous or rudimentary. Several species rival the humming birds in the brilliancy and play of their colors. *A. aculeata* (*pl.* 77, *fig.* 15), of the European seas, attains a length of six inches, and the dorsal scales are hidden by a hairy covering.

Fam. 2. *Amphinomidæ.* Segments similar, branchiæ ramose, tufted, or plumose, well developed, dorsal, or at the base of the feet; head distinct, mouth unarmed, no aciculi, feet with one or two branches.

Fam. 3. *Eunicidæ.* The rostrum has from seven to nine corneous jaws; branchiæ wanting or well developed, in the form of pectinated filaments; feet aciculate. *Eunice* has two eyes, seven strong jaws, four upon the left and three upon the right side; five large tentacles above the mouth, and two smaller ones at the nape; branchiæ pectinated upon one side of the supporting branch. The body is long and sub-cylindrical, the segments sometimes numbering four hundred. This genus contains the largest species of annelida known, *E. gigantea* of the Antilles, which is four feet or more in length.

Fam. 4. *Nereidæ.* In this family the jaws are either absent, or amounting to two or four; the rostrum extends considerably beyond the head; antennæ mostly well developed. *Nereis* is a genus of worms found upon the coast, moving about freely, or hidden in the cavities of rocks, or in dead shells; and sometimes sunk in the mud. Like many other annelida, it is used by fishermen as bait. Some are of a considerable size, and the colors are often agreeable. *Phyllodoce* (*pl.* 77, *fig.* 11) belongs to this family. The place of *Spio filicornis* (*fig.* 14), which has two very long antennæ, is not ascertained.

Fam. 5. *Ariciidæ.* Head and rostrum distinct; antennæ, eyes, and branchiæ wanting, or rudimentary; jaws and tentacular cirri absent; each foot with a single cirrus.

Fam 6. *Peripatidæ.* This family contains the single genus *Peripatus* of Guilding, who observed it in the West Indies, and described it as a mollusc. The body is somewhat limaciform, both ends obtuse, the annulations not very distinct, each side margined with a row of short, thick,

conical and granular feet, decreasing in size from the middle of the body towards each end, and having short bristles at their extremity; no cirri, gills, nor similar appendages. The head is distinct, with two stout annulate antennæ, and the mouth has a pair of corneous jaws. *Peripatus juliformis* of Guilding, from which the characters are taken, is three inches long, dark brown, annulated with yellow, the dorsal line black; and it has thirty feet on each side. Lacordaire found a specimen in Cayenne, sunk in the mud at the margin of a river, and Goudot found another species near Table Mountain in South Africa, under a stone in a shady place. The nervous system differs from that of the other annelida in being bilateral (somewhat as in Malacobdella); and on this account, Gervais is of opinion that it forms the type of a distinct group of worms, whilst Milne Edwards, who discovered this peculiarity, considers it as indicating a passage to Nemertes. See Kirby's Bridgewater Treatise, p. 259, pl. 8, fig. 1, 2.

Fam. 7. *Chætopteridæ.* The genus *Chætopterus* was formed by Cuvier for a worm from the Antilles, eight or ten inches long, inhabiting a tube of a parchment-like consistence, whence its name *Ch. pergamentacerus.* There are neither rostrum, jaws, nor a proper head. There is a lip with two rudimentary antennæ, followed by a disk with eight or nine pair of feet, succeeded on each side by a wing-like projection, bearing bristles. The branchiæ are medial, and in the form of laminæ; posterior extremity with numerous lateral feet.

Fam. 8. *Arenicolidæ.* In *Arenicola* the body is cylindrical, composed of a moderate number of segments subdivided by numerous wrinkles. The head is rudimentary, with a small terminal rostrum; no jaws, eyes, antennæ, nor cirri. The feet have two branches, and are armed with simple and armed bristles; branchiæ in bunches divided like the branches of a tree, and arranged in pairs along the middle portion of the body, numbering from thirteen to twenty pair. They burrow in the sand about low water mark, and are extensively used by fishermen as a favorite bait for marine fish. *A. piscatorum* is eight or ten inches long.

Order 3. Cephalobranchia (or *Tubicola*). These sedentary annelida live in calcareous, sandy, or membranaceous tubes; the soft appendages are generally confined to the anterior extremity; the head is indistinct, without eyes, rostrum, or jaws; the branchiæ are plumose, and situated at the anterior extremity (*pl.* 75, *fig.* 68). They comprise the two families *Serpulidæ* and *Amphitritidæ.* The former is distinguished from the latter by having the branchial plumes separated into two masses by a pedunculated operculum, or covered by a solid one when withdrawn within the shell.

Fam. 1. *Serpulidæ.* The genus *Serpula* (*pl.* 75, *fig.* 70) has the body tapering posteriorly, the mouth terminal, and surrounded with a crown of long, feathery, and often finely colored branchiæ, which give the animal the appearance of a zoophyte. These are used in taking the small living objects upon which they feed. The feet are lateral, the seven anterior pair attached to a membranous base. The part bearing these feet forms a kind of thorax distinguishable from the remaining part of the body. From the internal base of each of the two masses of branchiæ a filament arises, one of which

has its extremity enlarged into an operculum for closing the aperture. The tubes which these animals secrete are calcareous, and twisted in a very irregular manner. They are affixed to submarine bodies, either singly, or a great many in a single mass. The tubes are common in the tertiary and secondary formations.

Fam. 2. *Amphitritidæ.* In this family the indistinct head is composed of three segments, the thorax of not less than twelve, and the abdomen of a great many. The mouth has numerous prehensile tentacular filaments, and the tube is formed out of a mucous secretion to which extraneous objects, such as fragments of shells, are affixed. They live singly or aggregated. *Amphitrite* (*pl.* 77, *fig.* 13), *Sabella* (*pl.* 75, *fig.* 68), *Terebella* (*pl.* 76, *fig.* 82). The genus *Hermella* resembles the Dorsibranchia in having the branchiæ dorsal; the cephalic appendages not being branchiæ but tentacles, according to Milne Edwards.

Class 2. *Cirrhopoda.*

The animals of this class are monoicous, inclosed in a hard shell or subgelatinous envelope, deprived of locomotive powers, and affixed to extraneous submarine bodies, some by a peduncle (*pl.* 76, *figs.* 51, 52), and others by their base (*figs.* 53, 54). The earlier authors placed these animals with the Mollusca, and the shells are often retained in conchological cabinets. Their articulated cirrhi and double nervous axis indicate their true nature; and whilst they have been made a distinct class from the Crustacea, partly on account of the supposed absence of an articulate structure, Dr. St. Ange affirms that evident traces of such a structure exist.

These animals undergo a metamorphosis, the young being bivalvular like bivalve mollusca, and capable of swimming about freely for some time before it affixes itself permanently. In this condition the limbs can be protruded from the front of the shell; the anterior pair being large, and provided with a sucker and hooks for attachment to submarine bodies. The six posterior pairs are used in swimming. The animal, at this period, bears considerable resemblance to the small branchiopoda. Mr. Thompson, of Cork, placed some of them in a vessel of sea water, and in a week's time two of them had mantled and were affixed to the vessels as barnacles. A few days afterwards, another individual was observed to throw off its shell and affix itself. Both the orders of Cirrhopoda undergo these changes.

The jaws are lateral, articulated, and toothed; the cirrhi are articulated, curved, and arranged along the abdomen, resembling somewhat the members along the lower surface of the tail in the Crustacea. The class contains the two orders *Campylosomata* and *Acomptosomata*, both of which are widely distributed by floating wood, ships, sea-weed, mollusca, whales, turtles, &c.

Order 1. Campylosomata. This order contains the pedunculated flattened forms like *Mitella* (Oken, 1815; *Pollicipes*, Leach, 1817, *pl.* 76, *fig.* 51), and *Lepas* (Linn., 1748; *Anatifa*, Brug., 1792, *pl.* 76, *fig.* 52), in which the shell is generally composed of two large lateral triangular basal

pieces, followed by two smaller pieces with a fifth dorsal piece. Sometimes there are accessory pieces at the base, and the whole are in some cases so much reduced in size as to be rudimentary like the shell in *Chitonellus* (p. 81). Sowerby's genus, *Lithotrya*, occupies holes in rocks; but it is not known whether it forms them, or takes possession of those previously made by boring mollusca.

Order 2. Acamptosomata. In this order the animal is short and conical, without a peduncle, the shell solid and conical, sometimes sub-cylindrical, with the base or attached portion open or closed, the aperture provided with a two-valved or four-valved operculum. Those of the order known to the ancients were named *Balanus* (*pl.* 76, *fig.* 54), on account of their resemblance to an acorn, a name which is still retained. They were a favorite article of food with the ancients. The natives of Chili eat a very large species, *Balanus psittacus*, which is five and a half inches high by three and a half in diameter; it has much the taste of a crab. The young of this species are attached to the adults, and in turn support their desendants, so that they occur in large masses of fifty or a hundred individuals.

Some genera, as *Pyrgoma*, are buried in coral; *Acasta* inhabits sponges; *Chelonobia* is attached to turtles; and *Tubicinella* and *Coronula* (*pl.* 76. *fig.* 53) are imbedded in the skin of whales.

Class 3. Crustacea.

In this class the sexes are separate; the body and limbs are distinctly articulated; the breathing is by means of gills, or more rarely (in some of the lower forms) by the external surface. The larger forms, as the lobsters and crabs, and the great majority of the smaller ones, inhabit the sea, where they take the place of the insects which are so abundant on land. Some species inhabit the fresh waters, and a few the land. The larger species are many times the bulk of the largest insects, from which they decrease to forms of microscopic size. In some of them the characters of the class are so obscure that they have been placed with the parasitic worms. Named from the hard integument, this affords a prominent characteristic, being a calcareous exterior skeleton of considerable thickness and strength in the larger species; becoming more delicate, and often transparent in the smaller ones, to disappear, or to escape observation in some of the obscure forms. This covering is periodically cast off and renewed, like the integuments of certain reptiles, and the larvæ of insects.

In comparing various members of this class (*pl.* 78), the number of segments, and the consequent ability to bend the body, will be found to be very variable, so that whilst the body of some (*figs.* 1–9) is a solid box incapable of flexure, that of others is composed of a number of loosely connected segments moving freely, and chiefly downwards from the horizontal position. This allows some of the members of the class to roll themselves into a ball by approximating the head and tail.

The normal number of the segments in the body of the Crustacea is

twenty-one, of which seven belong to the head, trunk, and tail, respectively, and when a smaller number appears, it is generally to be attributed to the fusion of several into one. In *fig.* 22, *pl.* 78, the head is observed to be distinct, whilst in *fig.* 1 it forms a single piece with the trunk, the tail being articulated and turned beneath, although partly visible in *figs.* 3 and 8. In *Limulus* (*fig.* 34), the segments of the tail are fused into a single shelly plate, as well as those of the head and trunk or cephalo-thorax, the shield or plate of which is called the carapace.

The moulting of the larger crustacea takes place about once a year, but Mr. Lyell mentions a species of *Cancer* covered with oysters six years old, so that the shell could not have been renewed during this period. Young and growing animals moult frequently, as in Daphnia, which may change every two days. Previous to moulting, a crustacean becomes sickly and refuses food, the carapace becomes loösened, and the corium beneath secretes a new, soft, and membranous shell, which finally becomes calcareous. When the old shell has become loosened, the animal, after various exertions, extricates itself from it in about half an hour, withdrawing the antennæ, feet, and even the gills, from an external film. The shell of the limbs splits to allow the large extremity to pass, and it sometimes happens that a limb is left in the old shell. Some of this class have the power of throwing off a limb.

The Crustacea feed mostly upon animal food, which is taken sometimes solid and sometimes in a liquid state, and the oral organs are modified accordingly. Some small species are very destructive to the timber of ships and docks.

In forms like the lobster, swimming is effected by striking downwards and inwards with the tail, which forces the body in a backward direction. In the *branchiopoda* the feet are used in swimming, not being adapted to walking; and in the *entomostraca* (*figs.* 27, 29), the body is impelled through the water by the feet, in a succession of jerks.

The walking feet of the Crustacea generally amount to ten or fourteen. In some (*fig.* 1, &c.), the anterior pair are robust, the extremity provided with a movable thumb forming pincers. Sometimes the end of a foot can bend, so as to form a hook; and in other cases the last joint closes upon an extension or enlargement of the preceding joint, forming an organ of prehension.

There are two mandibles, four lower jaws, succeeded by six auxiliary or foot-jaws, followed by the feet; and when there are fourteen feet, the four anterior ones are transformed from the four posterior foot-jaws.

Most of the Crustacea see well, and the eyes are either sessile or placed upon pedicles. Some of the parasitic species are without eyes in their perfect and affixed state, although provided with them when young, and capable of swimming about. As in the insects, both compound eyes and stemmata are found in this class, but the former are the most common. In a few cases both are found together.

There are sufficient reasons to believe that the sense of smelling is present in the Crustacea, although its special organ has not been discovered.

There are four antennæ, of which the second pair is supposed to be connected with the sense of hearing, because there is near the base a cavity filled with a liquid, and receiving a special nerve. It has an exterior orifice closed with a membrane, which may be compared to a tympanum.

The Crustacea are oviparous; and when the young leave the egg, some resemble the adult of the species to which they belong, although most of them undergo a metamorphosis. Mr. J. V. Thompson, of Cork, discovered an individual of Bosc's supposed genus *Zoea*, to be only the young of the common crab; and Jurine had observed the change which the small fresh water species undergo. The young of Lernæa and the allied genera are much like those of Cyclops.

There are two sections of the Crustacea: *Entomostraca*, in which the number of legs varies; and *Malacostraca*, in which there are ten or fourteen legs.

Entomostraca.

Order 1. Rotatoria (or *Rotifera*). This order has already been alluded to (pp. 9 and 25) in treating of the Infusoria. It is divided into such as are naked and such as have a shield, and each of these series has three sections according to the arrangement of the vibrillæ. According to Ehrenberg, this order contains fifty-five genera, divided into eight families; but Dujardin reduces the families to five, and the genera to twenty-four. The genus *Rotifera* (*pl.* 75, *fig.* 16) includes species less than half a millimetre long, which live in water, or among damp moss. The mouth and tail are capable of holding, so that the animal can move by attaching each end alternately, as in the leeches. They have also the power of swimming through the water by means of the vibrillæ. When at rest they affix themselves by the tail and bring their food within reach in the currents caused by the vibrillæ. Burmeister, in his work on the *Organization of Trilobites*, 1843, places the *Rotatoria* as the lowest of the Crustacea, and next to them the *Cirrhopoda*, under the belief that the latter do not form a distinct class; and in 1842, J. E. Gray placed the Cirrhopoda here. These animals, and the Rotatoria, are monoicous.

Order 2. Cormostomata. Sexes separate, mouth with a suctorial beak, carapace generally in a single piece, feet adapted for holding, walking, or swimming. Parasitic upon fishes, and undergoing metamorphosis. The order, as given here, includes two of Milne Edwards's orders, which contain five families conjointly. It includes Baird's *legion Pœcilopoda*, which is divided into two orders, five tribes, and eleven families, as given in his Natural History of British Entomostraca, 1850. This order has been named *Siphonostoma*, but as this designation has been otherwise employed, that of Professor J. D. Dana is adopted. This author gives it as a sub-order containing four tribes. (Proceed. Am. Acad. of Arts and Sci. vol. ii. p. 53.)

The *Lernœidœ* (*pl.* 76, *figs.* 80, 81) are without eyes; the head is small and the thorax large, the separation being sometimes obscure, and the thoracic organs are rudimentary. The single pair of antennæ is sometimes absent, and the number of foot-jaws is two or four. The body is curiously

shaped, and irregular in the various genera, in some presenting the appearance of a mal-formed worm, and indeed, some authors have placed them among the worms, and others among the zoophytes. Dr. George Johnston remarks, that "of all the curious creatures which the naturalist meets with in his researches, there are none more paradoxical than the Lernææ; none which are more at variance with our notions of animal conformation, and which exhibit less of that decent proportion between a body and its members which constitutes what we choose to call symmetry or beauty. Of its paradoxicalness, no better proof can be given, than the difficulty which the most experienced systematists have found in determining the proper place and rank of the family among organized beings." Kroyer, as quoted by Baird, says that "the exterior of these animals is often so highly fantastical, that we are disposed to admire the freaks of nature in bringing forth such forms. But it is evident, that when continued observations and investigations have put us in possession of the condition of these forms, we shall see here, as everywhere else, that singularity resolves itself into regularity."

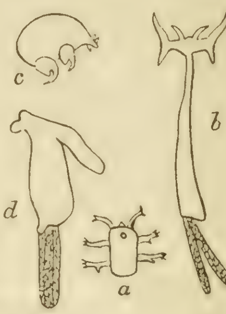
Suriray threw a light upon the affinities of these animals by discovering that the appendages at the extremity of the body (*Lernæa*, *pl.* 78, *fig.* 30, inverted) are egg pouches, as in the admitted Crustacea like *Cyclôps* (*pl.* 78, *fig.* 27). Audouin and Milne Edwards announced the opinion in 1826, that these animals are Crustacea which become monstrous after they have become permanently affixed as parasites. The organization was first satisfactorily ascertained by Nordman; and the knowledge respecting them, although far from complete, has now arrived at such a point, that their station among the Crustacea may be considered to be well ascertained. These results are due chiefly to the labors of Burmeister, Rathke, Kroyer, and Kollar.

Aristotle and Pliny mention several fish which are infested by these parasites, and Conrad Gesner gave an extended history and figure of a species in 1558, Rondeletius having figured it four years previously. These authors state that it infests the tunny and swordfish, in the flesh of which the anterior extremity is buried, and so firmly fixed that it is difficult to remove without breaking it. Some are found sticking in a similar manner in the eyes of fish, and others to their gills, mouth, or under their fins, where they are less firmly attached.

For a long time the female alone of these animals was known, and it was a subject of wonder how they became transferred from one fish to another, being perfectly stationary and incapable of locomotion; and when carefully removed from their position, but few of them show any signs of life, although some move the head and jaws for a short time. The mode of reproduction was also an obscure point in their history. The ovarian sacs, of course, indicated the female sex, unless all the individuals were supposed to be monoicous. But some individuals were at length found without sacs, and these were naturally taken for males, until Kroyer discovered them to be females after the eggs had been cast and the sacs had disappeared. Nordman at length found adhering to some of the females, certain small

living bodies unlike the females, but somewhat like the young, and these he considered males, a view in which Kroyer concurs. These males are much smaller than the females, and those of different species resemble each other, even when the females are quite dissimilar.

When the young leave the egg, they bear a remarkable resemblance to those of Cyclops, Apus, and other undoubted Crustacea. They have a large eye, a pair of antennæ, two pair of large swimming feet, by means of which they swim through the water until they find a proper station to which they can attach themselves, as already described in the Cirrhopoda, and other groups of the lower animals. As in the higher forms, they moult frequently during their growth. After affixing themselves, the feet disappear, or are transformed into foot-jaws or other organs adapted to their new mode of life. The eye being now useless, disappears also. In some, two long arms appear (see the inverted *figs.* 30, 31), which are united at the apex, where they form a sucking cup, with its concavity armed with teeth, forming an organ which is immersed into the flesh of fishes, and is used in maintaining the place of the animal. This metamorphosis, by which an animal is apparently less perfect in the adult state that when a larva, is styled *retrogressive* by Burmeister.



In the annexed figure, *a* represents the young, and *b* the adult female of *Lernæocera*, a genus named from the horn-like projections upon the head. The body is slender, the feet are entirely absent in the adult, and the thorax includes most of the body, the abdomen being very small. *L. cyprinacea* (*b*) is about eight lines long, and was discovered by Linnæus, in 1746. Figure *c* represents the male, and *d* the female of *Anchorella uncinata*. The former is globular, and affixes itself by means of two pairs of hooks. The rudimentary abdomen of the latter is at the base of the egg sacs. It is one fourth of a line long, whilst the female is six or eight lines. The long projection in the figure of the latter represents the arms. This species is found upon the fins and gill covers of the cod and haddock.

Achtheres percarum (*pl.* 78, *fig.* 31), the female of which is two lines long, affixes itself to the tongue, inside of the mouth and eyes of *Perca fluviatilis*. The alimentary canal is straight, without any division between stomach and intestine, and the nervous system is said to consist of a longitudinal cord on each side of it.

The *Caligidæ* are distinguished from the *Lernæidæ* by the better developed organs of motion. The foot-jaws are well developed, and the thorax has several distinct rings and pairs of feet. Like the preceding family, this one is divided into several sub-families. *Caligus* (*pl.* 74, *fig.* 34) has a very large depressed circular head, with large frontal plates having a sucking disk laterally beneath. There are eight feet, and the antennæ are small and bi-articulate. They inhabit the sea, and affix themselves, with the aid of their foot-jaws, to the body or branchial cavities of fish. They

readily move from one part of the fish to another, going either backwards or forwards; or leaving the fish, they swim freely through the water. In dissecting them, Pickering and Dana found no blood in the stomach at any time, whence they conclude that the food is the mucus upon the surface of the fish. The cylindrical egg tubes of the female are in some species several times the length of the body in this family, the eyes forming a single row. The integument is renewed periodically. The following genera belong to different sub-families.

Ergasilus (*pl.* 78, *fig.* 29), which is parasitic in the gills of fishes, bears a considerable resemblance to *Cyclops* (*fig.* 27). They are of a minute size, and when they leave the egg, they have three pairs of swimming feet. The male has not yet been detected.

Phyllophora (*P. cornuta*, *pl.* 78, *fig.* 28) is remarkable for certain dorsal scale-like appendages somewhat analogous to those of the Annelides, as Aphrodite. The single species known is found at Tongatabu.

Order 3. Branchiopoda. This order includes a considerable number of marine and freshwater species, generally of small size, the head distinct, the eyes generally close to the median line, and often in contact, and apparently single, giving rise to the names *Cyclops* and *Monoculus*. They swim freely through the water, either with a uniform motion or by a series of jerks, the organs of motion being the feet, tail, and more rarely the antennæ. They have a pair of mandibles, one pair of foot-jaws, and an upper and lower lip. Some authors, who consider this group to be of a higher value than an order, divide it into orders and other sub-divisions. The families here given (except the *Cyprididæ*) admit of a further division into sub-families, groups which are sometimes considered to be families.

Fam. 1. *Cyclopidæ*. *Cyclops* (*pl.* 74, *fig.* 33) is a freshwater genus in which the body is pyriform, and tapering posteriorly; the head not distinctly separated from the thorax, and having the eye near the anterior extremity. The superior or larger pair of antennæ are used to assist in locomotion, and they vary in the two sexes, being usually shorter in the male, besides differing in other characters. Some of the marine species are phosphorescent. The freshwater species inhabit stagnant water and springs, where they may be seen with the naked eye jerking themselves through the water, if looked for attentively. The females may be distinguished by the large pair of egg sacs (*pl.* 78, *fig.* 27) when these are present. The young undergoes a metamorphosis, which lasts about twenty days. Jurine, who has published an elaborate work upon these microscopic creatures, cut off about two thirds of the antennæ of a female Cyclops, but observed no change in the mutilated organ until the animal moulted, when both antennæ appeared alike perfect. Inhabiting ponds which often disappear by desiccation, these animals and those of the neighboring families reappear with the first rain, having doubtless remained in the mud or damp earth. When removed from water and dried fifteen or twenty minutes, but few survive, and none when the interval of dryness reaches twenty-five minutes. They will recover their activity after having been thoroughly frozen. They are carnivorous, and when other food is not at hand, they devour their own

young. These animals are extremely prolific, and furnish food to the aquatic larvæ of insects. *Cyclops setosa*, Hald., Jour. Acad. Nat. Sci. viii. 331, is the American analogue of the European *C. quadricornis.*

Fam. 2. *Cyprididæ* (*Ostracoda* of Latreille). In this family the animal is inclosed in a bivalve shell with a dorsal hinge, and capable of being closed when the antennæ and feet are withdrawn. There are four antennæ, those of the second pair being large, elbowed, and adapted to assist in swimming. Most of the species are minute, inhabiting fresh or salt water. The species of the genus *Cypris* are abundant during the summer in puddles of stagnant water, where they may be seen swimming about or walking upon objects at the bottom. The eye is of a dark color, and the shell sufficiently translucent to allow it to be seen at the upper and anterior part. The eggs are attached to extraneous bodies, and the young are not subject to metamorphosis. Their food is stated to be dead animal matter, and confervæ. Many of the species are beautifully marked with variations of color. The following American species are indicated in the Proceed. Acad. Nat. Sci. vol. i. pp. 53 and 184: *Cypris agilis*, *C. simplex*, and *C. scabra*, Hald.

Fam. 3. *Daphniidæ* (or *Cladocera*). Here a bivalve shell incloses the body, with the exception of the head, which is distinctly exposed, and bears a large compound eye capable of some motion. The inferior antennæ are very large, and generally two-branched. There are four, five, or six pairs of feet, which afford characters for the sub-families; or families, if the Cladocera are considered to constitute an order. Daphnia is abundant in the stagnant pools where Cypris and Cyclops are found, and their locomotion resembles that of the latter. The young are retained between the body and shell posteriorly above, where they may be seen through the latter. The Daphniæ are so abundant as sometimes to discolor the water, the red species giving it somewhat the appearance of blood. Dr. W. Baird, in his Natural History of the British Entomostraca, 1850, p. 78, says he has "frequently seen large patches of water in different ponds assume a ruddy hue, like the red rust of iron, or as if blood had been mixed with it, and ascertained the cause to be an immense number of *D. pulex.* The myriads necessary to produce this effect are really astonishing, and it is extremely interesting to watch their motions. On a sunshiny day, in a large pond, a streak of red, a foot broad, and ten or twelve yards in length, will suddenly appear in a particular spot, and this belt may be seen rapidly changing its position, and in a very short time wheel completely round the pond. Should the mass come near enough the edge to allow the shadow of the observer to fall upon them, or should a dark cloud suddenly obscure the sun, the whole body immediately disappear, rising to the surface again when they have reached beyond the shadow, or as soon as the cloud has passed over."

At certain periods Daphniæ may be found with a black saddle-shaped appendage (named the *ephippium*) upon the back of the shell, which Strauss discovered to be a receptacle for two eggs from which to reproduce the species in the spring. At the fifth moult, the ephippium is cast off and floats about at random, protecting its contents until the succeeding spring. *Daphnia abrupta* and *D. fenestrata*, Hald., Proceed. Acad. i. 184, 196, are

American species. The name of the latter is changed from *reticulata*, as this has been already applied to a European species.

Fam. 4. *Apodidæ.* This family includes Latreille's fifth order, *Phyllopoda*, in which the body is either naked, inclosed in a bivalve shell, or with the head and thorax covered with a carapace. The body is divided into a great number of segments, most of which have foliaceous feet adapted for breathing, the number of which varies from eleven to sixty pair. Antennæ two or four in number, and not adapted for swimming; eyes two or three.

Apus (*pl.* 78, *fig.* 25) has a large carapace covering nearly the entire body; one pair of short antennæ, and sixty pair of branchial feet. Schæffer enumerated the number of pieces which enter into the composition of the body, and found them to amount to 1,802,604. He found that each of the caudal filaments in *Apas cancriformis* contains 480 articulations. It inhabits fresh water ponds, and swims equally well with the back above or below. It reappears in desiccated ponds in two days after a rain; and it has been found in ponds that have been without water for several years, whence it may be inferred that the eggs retain their vitality for a long time. They feed upon the microscopic Entomostraca, and are in turn devoured by frogs.

The metamorphosis of *Apus* is much like that of Cyclops, Lernæa, &c. When the young leave the egg, the body is narrowed posteriorly, the tail is wanting, the antennæ are large, and the first and only pair of feet are robust, and longer than the body, thus presenting opposite characteristics from the adult. The length of the common European species, *A. cancriformis*, is two and a half, and the breadth one and a half inches. There are but few species known. One has been described from the West Indies, one from the eastern side of the Rocky Mountains, and another from the Sandwich Islands.

Branchipus pisciformis (*pl.* 78, *fig.* 26) was described under this name, according to W. Baird, by Schæffer, in 1752, and was subsequently named *Chirocephalus diaphanus*, by Prévost. It has two pedunculated eyes, four antennæ, eleven pairs of branchial feet, and there is no shield. In the male, the larger pair of antennæ are prehensile, resembling mandibles, their base is large and fleshy, and the outer joint curved and cylindrical. From the base of these antennæ arises a pair of large flexible proboscidiform organs with their appendages, all of which are usually rolled up beneath the head. In the female the large antennæ have a singular structure, being short, compressed, bent downwards, pointed at the end, and unprovided with appendages. The species figured is more than an inch long, and is found in pools swimming upon its back. As in nearly all the Entomostraca, the branchial feet are kept moving continually. These animals swim with the aid of the tail, darting through the water like small fishes. They feed upon dead animal and vegetable matter. The female has an external branchial sac, and the young undergo a metamorphosis.

Limnadia is inclosed in a bivalve shell somewhat as in Cypris, but the animal is larger, being nearly half an inch long. The American species,

L. coriacea, Hald., 1842, was found in a puddle a few inches deep, which was subject to desiccation; and although a number of living individuals were transported to a little pond not liable to be dried up, the species has not been seen since, in these or other localities.

ORDER 4. TRILOBITES. These animals are known only from their fossil remains, which are limited to the crustaceous covering. In most cases the body is divided into three lobes by two longitudinal impressions, and into transverse segments. The shield of the head is composed of a single piece, followed by the thoracic segments, and these by the shield of the posterior extremity or abdomen, which varies much in size, and is either plane or marked with transverse impressions like those which separate the thoracic segments. The cephalic shield or buckler is large, more or less semicircular in front, truncated or concave behind, and generally divided into three longitudinal lobes corresponding to those of the trunk. When they are present the eyes are situated upon the inner portion of the exterior lobes. They are in the form of a more or less elevated tubercle, which is sometimes semilunar or reniform. In some the surface is smooth, whilst in others it is composed of numerous facets forming a compound eye. In the opinion of Burmeister, the eyes of all the Trilobites are compound, and covered with a smooth cornea; and when this has disappeared, the faceted portion is exposed to view. To effect this, the cornea must have been thinner and more destructible in the genera in which faceted eyes appear.

The thorax is composed of a variable number of distinct segments, which are arched over the back into the longitudinal grooves, whence the lateral flattened portions, or pleuræ, project and form the external margin, where they are bent beneath and doubled upon themselves. The thoracic segments are generally composed of a wide and narrow portion, the latter being anterior and covered by the posterior margin of the preceding segment, unless the body is bent, when this portion appears. The number of segments in the thorax varies from six (in one case but two) or eight to twenty.

Feet have never been found with the Trilobites, so that it is probable that they did not exist as solid members, but resembled the corresponding parts in the Branchiopoda.

The remains of these animals are found abundantly in the palæozoic and carboniferous formations of various parts of the world.

Burmeister, who has written an elaborate and satisfactory work on the organization of the Trilobites, assigns reasons for believing them to be allied to the branchiopoda, with similar habits, swimming by means of their soft gill feet; just beneath the surface of the water, with the back below, having the power of creeping upon the bottom, feeding upon small marine animals, and rolling themselves into a ball (those able to do so) as a defence. They probably lived gregariously in the shallow waters of bays and coasts, with but few species in a single locality.

Milne Edwards places the Trilobites between the Branchiopoda and the Isopoda, to the latter of which they have only a distant external resemblance, and the absence of articulate feet indicates a wide difference.

Order 5. Xiphosura. This order is here restricted to the single genus *Limulus* (*pl.* 78, *fig.* 34), which Burmeister makes a tribe, under the name of *Pœcilopoda*, a name which has a very different value assigned to it by other authors. On this account we prefer the name given by Gronovius. The terms *Epizoa* and *Parisita* are also used in such a manner as to cause confusion, being applied both to the *Lernæidæ* and to the *Anoplura* or lice. Limulus is remarkable for the long, hard, and sharp caudal spine, with which spears are pointed in some countries. They are called king-crab on the coast of the United States, where they are collected as food for hogs, although these animals will not attack them until accustomed to such an unusual kind of food. The body is covered by a large anterior carapace, and a smaller posterior one, the gill feet are attached to the abdomen, and six pairs of strong articulated ambulatory feet to the thorax. The latter are present in the fossil species which have been discovered. The caudal stylet is wanting in the embryonic young, which differs from the adult in some other particulars. The species live upon animal food.

Malacostraca.

Order 6. Isopoda. In this order the body is depressed and oval, and there are seven pairs of feet attached to the seven movable segments of nearly equal size which form the thorax (*pl.* 78, *figs.* 20–22). The young resemble the adult, but they have only six pairs of walking feet. Some of the species are parasitic upon fishes or Crustacea, and these have the organs of motion and the eyes rudimentary. Most of the species are marine, although some inhabit the fresh waters, and others the land, the last requiring damp localities to preserve their gills from desiccation. The four antennæ are of a medium size, and directed in front, the first pair being in some cases rudimentary. The organs of manducation are well developed, the thorax occupies a great part of the body, the feet are armed with a single nail, and in some cases they are prehensile. The females have a corneous horizontal plate at the base of the feet, which forms a receptacle in which the eggs are hatched. The abdomen is in the form of a terminal plate above, and beneath it supports six pairs of organs, five of which are respiratory false feet, and the sixth takes various forms, according to the family.

Milne Edwards divides the order into three sections, according to their *walking*, *swimming*, and *sedentary* habits. The first includes the *Idoteidæ*, *Asellidæ*, and *Oniscidæ;* the second the *Sphæromidæ* and *Cymothoidæ*, under a different mode of division from that of Latreille; and the third the *Epicarides* or *Bopyridæ*, under two families.

The walking *Isopoda* have the terminal false feet in the shape of operculums, or of projecting caudal stylets, which are never flattened into swimming organs; the first pair of antennæ are generally short or rudimentary.

In the swimming *Isopoda* there is a large caudal fin provided with lateral expansions formed by the modified fourth pair of false feet. All the antennæ have the same form, and the second pair are well developed.

The sedentary *Isopoda* are parasitic, and whilst the males present the

general characters of the order, and have seven thoracic and five or six abdominal segments which are quite distinct, the females are misshapen, with the segments of the body indistinct. The thorax is narrow in the male and wide in the female, and the eyes are present in the former and absent in the latter. The antennæ are more or less rudimentary, and the feet very short, submarginal, and formed for holding, but not adapted for walking and swimming. The male is much smaller than the female.

Latreille divides the *Isopoda* into six families, corresponding to the following names: 1, *Bopyridæ;* 2, *Cymothoidæ;* 3, *Sphæromidæ;* 4, *Idoteidæ;* 5, *Asellidæ;* 6, *Oniscidæ.*

Fam. 1. *Bopyridæ. Bopyrus crangorum* is found affixed to the gills, and beneath the shell of several large Crustacea, as *Palæmon* and *Hippolyte.* The male is only one fifth or one sixth the size of the female, and is found under the abdomen of the latter. When the young leave the egg, they are much like those of Cyclops.

Fam. 2. *Cymothoidæ.* Most of these are parasitic upon marine fish, to which they affix themselves with the aid of their strongly hooked feet. The body is lengthened oval, narrowing towards each end, the head is small, and the feet are large and operculiform. The young leave the egg with only six pairs of feet, and at this period the abdomen is adapted for swimming. Some are sedentary, and others possess the power of walking. The subfamilies are the *Serolinæ*, *Cirolaninæ*, and *Nerocilinæ.*

Fam. 3. *Sphæromidæ.* The genus *Sphæroma* (*pl.* 78, *fig.* 21) has the thoracic segments nearly alike in form and size, the feet slender, and the false feet (except the last pair) received into a cavity beneath the abdomen. The species live among submarine plants, and they can roll themselves into a ball. *Cymadocea* (*pl.* 78, *fig.* 20) is allied to Sphæroma, but it is less flexible, and therefore not able to roll itself into a ball. It contains the two sub-families, *Sphærominæ* and *Ancininæ.*

Fam. 4. *Idoteidæ.* In this family the four antennæ are placed in the same line, and the first pair are very small. The body is slender, not much thicker in the middle, and truncated or concave posteriorly. The respiratory false feet are concealed in an opercular cavity beneath the abdomen. Subfamilies, *Arcturinæ* and *Idoteinæ.*

Fam. 5. *Asellidæ.* Body elongated and flattened above; the two pairs of antennæ are setaceous, and arranged in two lines, the first pair small. The abdomen is composed of one large scutiform segment without lateral swimmerets, and with two terminal stylets. Some of the species are marine, and others fluviatile. A species of *Asellus* is common in the fresh waters of Europe, and *A. communis*, Say, Jour. Acad. Nat. Sci. i. 427, is abundant in similar localities in the United States; and as it differs from the European representative of the genus in having the sides rectilinear, entire, and gradually diverging posteriorly, and the posterior segment being the widest as well as the largest, and transversely quadrate; we propose to give it the generic name of *Abacura*, from αβαξ a table, and ουρα the *tail.* The antennæ and caudal appendages are as in Asellus. It is half an inch or less in length, and may be found walking upon the bottom of springs.

Fam. 6. *Oniscidæ.* These animals are either marine or terrestrial, the first pair of antennæ are rudimentary, the second only being fully developed and conspicuous. The feet are slender, and formed for walking. The terrestrial genera (*Porcellio*, *pl.* 78, *fig.* 22) inhabit humid places, as cellars, crevices in walls, beneath stones or loose bark, and similar localities, feeding upon decaying vegetable matter. The female carries the eggs in a sac beneath the body. When the young first make their appearance, they have a segment of the body and a pair of feet fewer than the adult; and the head and antennæ are proportionally larger. The young are retained for a short time between the respiratory laminæ. *Oniscus affinis*, Say, is a common American species.

The singular marine genera, *Pycnogonum* and *Nymphon* (*pl.* 78, *figs.* 32, 33), with but four pairs of legs, were formerly placed in this, or the preceding or succeeding order, by various authors, but they are by many believed to belong to the Arachnida.

Order 7. Læmodipoda. The animals of this order are small, and present an unusual aspect. The head is small, the thorax has six segments, and the posterior extremity ends in a little tubercle corresponding to the abdomen. There are four antennæ; the mouth has a pair of toothed mandibles, two pairs of lamellar maxillæ, and one pair of foot-jaws. There are five or seven pairs of feet, and in the former case the missing ones are generally those of the third and fourth pairs, which are represented by lamellar scales. The feet are prehensile, and the first and second pairs have a kind of hand capable of holding; the former are affixed to the head, and the latter to the thorax. Branchial vesicles are attached to the second or third thoracic segments, and sometimes to the first. The order contains two families.

Fam. 1. *Caprellidæ.* *Caprella* (*pl.* 78, *fig.* 23) is a small and very slender animal with thin feet, a thick head narrowing posteriorly, and the first pair of antennæ larger than the second. The species live among marine plants, along which they walk in the manner of a leech. In swimming, they bend the posterior extremity and straighten it suddenly.

Fam. 2. *Cyamidæ.* *Cyamus* (*pl.* 78, *fig.* 24) is a genus found in colonies parasitic upon whales.

Order 8. Amphipoda. This order takes its name from having two kinds of feet, cheliform and simple, and because the feet vary in the position of the former. The body is compressed, the back generally arched, the mandibles with a palpus, the eyes immovable, and the posterior extremity generally with styliform appendages, and turned beneath. The segment next the head supports the first pair of feet, which correspond to the second pair of foot-jaws. The antennæ are slender and project in front. Most of these little animals swim with great vigor, by curving the tail beneath the body and jerking it back. There are fresh water as well as marine species, and they may be seen in most springs of fresh water. Some are found upon the beach under sea weed, or burrowing in the sand, and as they are too narrow to walk, they jerk themselves along whilst lying upon one side. There are two families, each of which contains several sub-families.

Fam. 1. *Gammaridæ.* In most of these, the thorax is composed of

seven segments, the first pairs of feet are well developed, and used in prehension, and the five succeeding pairs are ambulatory. *Orchestia* (*pl.* 78, *fig.* 18).

Fam. 2. *Hyperinidæ.* *Ancylomera* (*fig.* 19). These are generally parasitic upon fishes and medusæ. They swim well, but walk badly.

Order 9. Stomatopoda. Branchiæ abdominal and free, not affixed to the sides as in the Decapoda; abdominal appendages well developed. The shell is delicate and transparent, the thoracic carapace is large; and the body bears some resemblance to that of a lobster, being semi-cylindric, rounded above, and flat beneath, and the posterior extremity is obtuse and spinose. The large and conspicuous arm-like organs, which resemble the raptorial anterior feet of *Mantis* (*pl.* 80, *fig.* 90), present a remarkable character, and are doubtless used in taking their prey. The last articulation closes upon the previous one like the blade of a knife into the handle, and it is well adapted for holding. These organs correspond to the second pair of foot-jaws in the lobster and crab, and to the first pair of thoracic feet in the Isopoda. The oval laminated organ in front of these is an appendage of the second or external pair of antennæ. The last segment of the abdomen and the appendages of the sixth segment, form a caudal fin used in swimming, assisted by the three posterior pair of thoracic feet. *Squilla* (*pl.* 78, *fig.* 15); *Gonodactylus* (*fig.* 16). *Gonodactylus chiragra* inhabits the Mediterranean, the coasts of the Seychelles, America, Trincomalee, and Tongatabu. The order contains the two families, *Erichthiidæ* and *Squillidæ*.

Order 10. Diplopoda. This is usually included with the preceding, though Milne Edwards separates it as a distinct order, but without assigning to it a systematic name. That here chosen is in allusion to the appendages of the feet, which give them the appearance of being double. It is an order of small extent, of which *Phyllosoma* (*pl.* 78, *fig.* 17) is the type. The eyes are placed upon peduncles, the abdominal appendages are rudimentary, the branchiæ wanting, the body broad, thin, and scale-like, composed of a large cephalic shield, and a smaller thoracic one bearing the feet upon extensions of its margin. These animals are translucent, and so thin that it is difficult to perceive how there can be room for the internal organs between the upper and lower surface. In Phyllosoma the mandibles are large; the first and second pairs of mandibles, and first pair of foot-jaws, are small, and the second pair of foot-jaws are not raptorial. The feet are long and slender, and provided with palpiform appendages; and from the ease with which the feet are lost from the point where the appendage is attached, they are seldom seen perfect, so that the latter appears to be the true termination of the foot. The first pair of feet are small, and without a terminal nail, and generally without an appendage. The last pair are often rudimentary. The abdomen is sometimes confounded with the thorax, and at other times rudimentary.

Order 11. Decapoda. The individuals of this order, as the name implies, have ten ambulatory feet; the branchiæ are placed in lateral cavities beneath the sides of the large carapace; the head is immovable; the mouth has numerous organs between the mandibles and first pair of feet; and the

eyes are pedunculated. This order contains the largest of the Crustacea, as the lobsters and crabs.

Latreille divides this order into two families, named sub-orders by Westwood and tribes by Burmeister, who includes them with the Stomatopoda in his order *Podophthalma*, and gives each of these an equal rank with the Stomatopoda, Isopoda, and other orders. Milne Edwards divides the *Decapoda* into three sections, admitting the *Brachyura* and *Macrura*, but separating certain anomalous genera from both, but chiefly from the *Macrura*, to form the third section *Anomura* (also written *Anomoura*, and meaning, the *tail anomalous*).

In the *Anomura* the cephalothorax is large, the abdomen is not fully developed, and is much like that of the Brachyura. The second pair of external antennæ are well developed, the external foot-jaws are generally like feet; the three or four anterior pairs of feet are generally like those of the Brachyura, and adapted to locomotion, but the remaining ones are rudimentary, and in some cases used only for holding.

Fam. 1. *Paguridæ.* The genus *Pagurus* (*pl.* 78, *fig.* 10), and several others of the same family, are remarkable for having the abdomen weak and soft, and the two posterior pairs of feet much reduced in size, and not adapted for walking. These animals are protected by the empty spiral shell of a mollusc, and as they increase in size they crawl along the beach hunting a larger shell, and various trials are made until a suitable one is found, the old one being again and again resumed, until the animal has suited itself. The abdomen and small feet enter the shell, and when the animal wishes to be safe, it withdraws itself so far that the head and robust anterior feet close up the aperture like an operculum. The posterior extremity of the body is curved, and with the posterior feet, adapted to maintain the shell in a proper position. One of the anterior pair of feet is larger than the other, and both terminate in a pair of pincers or chelæ. The sub-families are *Pagurinæ*, *Hippinæ*, and *Porcellaninæ*.

Fam. 2. *Raninidæ.* In *Ranina* (*R. serrata*, *pl.* 78, *fig.* 9) the carapace is roughly serrated and transversely truncated before and narrowing posteriorly, producing a sub-triangular form. The anterior feet are cheliform, but not of a very large size, and the succeeding feet have the tarsus or last articulation lamellar. The abdomen is narrow, of seven articulations, the last ones bent downwards. The species figured inhabits the East Indies, and is said to crawl up objects, even to the tops of houses. The sub-families are: *Dromiinæ*, *Homolinæ*, and *Ranininæ*.

The *Macrura* are named from having a large and well developed tail or abdomen, ending in a fan-shaped fin (*pl.* 78, *figs.* 11–14). The form is generally elongated, the carapace longer than in the crabs, and generally armed with a frontal spine; and the species, with few exceptions, are marine. The antennæ are in general long, the first pair not received into a cavity as in the crabs; the mandibles are well developed; the walking feet are slender, and the first and second pairs frequently cheliform. The abdomen has seven articulations, of which the five basal ones bear the false feet. The caudal fin is formed of five pieces, the middle being an extension of the seventh or last segment, whilst the lateral ones arise from the sides of

the sixth. These Crustacea, although they walk well, must be regarded as chiefly swimmers, shooting backwards through the water by the action of the abdomen and caudal fin.

Fam. 1. *Scyllaridæ* (*cuirassés*, M. Edwards). In the genus *Palinurus* *pl.* 78, *fig.* 11) the body has much the shape of that of a lobster, but is more cylindrical, and none of the feet are cheliform, although the anterior ones are rather more robust than the others. The carapace is armed anteriorly with two large spines; the external antennæ are very long, with the base spiny; the basal segment of the abdomen is without false feet, although the four following have them. The species are of a large size; they have a very hard shell, and they live upon rocky coasts. The European species, *P. vulgaris*, attains a length of fifty centimetres, and a weight of eight kilograms. It is the *karabos* of Aristotle, and the *locusta* of Suetonius and Belon. The various species are more or less spinous. *Scyllarus* (*pl.* 78, *fig.* 12) is remarkable for having the peduncle of the exterior antennæ much dilated laterally, and more or less dentated, the terminal filaments being absent. The sub-families are: *Galatheinæ*, *Eryoninæ*, *Scyllarinæ*, and *Palinurinæ*.

Fam. 2. *Astacidæ.* This family includes the genus *Astacus* (lobster) and *Potamobia*, the analogous fresh water form known under the English names of crawfish, crayfish, crevish, or crevis, the three last of which agree in the first syllable. The latter are caught in Europe for food, by placing decaying meat in nets or bunches of brushwood, from which they cannot readily escape. They are also caught by a bait at the end of a stick, which they will not leave if it is withdrawn slowly, until a net can be passed under them. They are said to live twenty years, and to grow during this period. The genus is well represented in the United States. *Callianassa* (*pl.* 78, *fig.* 14). *C. major*, of Say, is four inches and a half long, and was found by this author "by digging in the sand of the bay shore of the river St. John, in East Florida, about eighteen inches below the surface, near low-water mark; it had formed a tubular domicil, which penetrated the sand in a perpendicular direction to a considerable depth; the sides were of a more compact consistence than the surrounding sand, projecting above the surface half an inch or more, resembling a small chimney, and rather suddenly contracted at the top into a small orifice." The second family, *fouisseurs* of Milne Edwards, is included in the *Astacidæ* by Latreille. The sub-families are: *Glaucothoinæ*, *Callianidinæ*, and *Astacinæ*.

Fam. 3. *Palæmonidæ. Palæmon*, which is much used for food, inhabits sandy bottoms near the coasts, or the mouths of rivers, and like the lobsters, boiling turns them red. *Stenopus* (*pl.* 78, *fig.* 13, exhibiting the false feet under the abdomen). The sub-families are: *Crangoninæ*, *Alpheinæ*, *Palæmoninæ*, and *Penæinæ*.

Fam. 4. *Mysisidæ.** Some authors place this family with the Stomatopoda. It includes two sub-families: *Mysisinæ* and *Leuciferinæ*.

* Under a different form this name might be supposed to be derived from Mysia or Mysidia, instead of Mysis.

In the *Brachyura* (*pl.* 78, *figs.* 1–9), the carapace is generally transverse, and square, oval, or circular, the abdomen is small, without a caudal fin, it is bent beneath and received into a depression of the thorax, and is not used in locomotion. The eye peduncles are generally longer than in the Macrura; there are two pairs of antennæ, one pair of mandibles, two of jaws or maxillæ, three of foot-jaws, succeeded by ten feet, the first pair having a pinching claw, the rest simple, and adapted in most cases for walking, but sometimes for swimming. The abdomen is wider in the female than in the male, and is composed of seven segments; but some of these are sometimes united together in the female, so as to present from four to six. Linnæus included the various genera of Brachyura in his genus *Cancer*, which corresponds very nearly to the English name crab. They are divisible into four families.

Fam. 1. *Leucosiadæ.* This family, called *Oxystomes* by Milne Edwards, includes the four sub-families, *Calappinæ*, *Leucosiinæ*, *Corystiinæ*, and *Dorippiinæ*, in which the shell is more or less orbicular, the eyes generally small, and the external foot-jaws triangular.

The *Calappinæ* form part of Latreille's *Cryptopodes*, named from the feet being partly hidden by the projecting margin of the carapace. The *Leucosiinæ* are much like the Cancridæ or ordinary crabs. *Philyra* (*pl.* 78, *fig.* 7) is a genus of small Crustacea, with the carapace circular and depressed. In the *Corystiinæ*, the external antennæ are robust and rather long, and the sternal plate narrow. In *Corystes*, the anterior feet are much larger in the male than in the female, and the abdomen has five articulations in the former and seven in the latter. The *Dorippiinæ* (*Dorippe*, *pl.* 78, *fig.* 8), which form part of Latreille's *Notopodes*, have the sternal plate circular and bent upwards posteriorly, the cheliform feet short, the two next pairs long, and the one or two last pairs, which are generally much reduced in size, are placed higher than the others, as if upon the posterior part of the back.

Fam. 2. *Ocypodidæ.* This family of Leach corresponds to the *Catamétopes* of Milne Edwards, in which the carapace is depressed, rhomboidal or ovoid, and the eye peduncles long and slender. The following are the sub-families: *Thelphusinæ*, *Gecarcininæ*, *Pinnotherinæ*, *Ocypodinæ*, *Gonoplacinæ*, and *Grapsinæ*.

Thelphusa is a genus of crabs which lives along the banks of freshwater streams. The *Gecarcininæ* (*Gecarcinus*, *pl.* 78, *fig.* 4) are remarkable for having branchiæ adapted to aerial respiration. They live among damp forests in holes which they make, and where they moult. Their food is vegetable, and they generally move about at night, or in wet weather. They visit the sea at certain periods, for the supposed purpose of depositing their eggs. They run with great agility, and like the crabs in general, in either direction. *Pinnotheres ostreum* is commonly found within the shell of *Ostrea virginiana* of the United States coast. In this genus the males are much smaller and more rare than the females. They are found within the shell of various bivalve Mollusca, as Pinna and Mytilus, where they are compensated for the weakness of their shell. The *Ocypodinæ* (*Ocypoda*, *pl.* 78, *fig.* 6; *Gela-*

simus, *fig.* 5) live upon the coast, digging holes several feet deep, where there is not too much sand to cause them to cave in, and some of the species run so rapidly that a man can scarcely catch them. *Ocypoda arenaria* inhabits the coast of the United States and the Antilles, digging a hole three or four feet deep, just beyond the limit of the surf, whence it wanders in search of food. According to Say, they hybernate at some distance from the water, in a hole made for the purpose, the mouth of which they close. *Gelasimus vocans*, known on the United States coast under the name of fiddler, has one of the anterior feet of the male much larger than the other, the large one being indifferently upon the right or left side.

Fam. 3. *Canceridæ*, including the *Portunidæ* and *Pilumnidæ* of Leach, is equivalent to the *Cyclométopes* of Milne Edwards, and includes, under two sub-families, most of the forms known under the name of crab. The sub-families are: the *Cancerinæ* (*Cancer*, *pl.* 78, *figs.* 1, 2) and the *Portuninæ* (*Thalamita*, *fig.* 3), which includes a great number of species under various genera. They are found near the coasts a considerable number together, and are taken for food. They feed upon living or dead animal food, particularly upon decaying carcases. Some of them attain a large size, *Pseudocarcinus gigas* being ten inches or more in diameter. The *Portuninæ* correspond to Latreille's swimming Brachyura, and are distinguishable from the Cancerinæ by the posterior feet being flattened and adapted for swimming, as represented in figure 3. In *Lupa*, the carapace is wider than long, and has nine tooth-like projections on each side before. The common edible crab of the Atlantic coast of the United States, has been described as *Lupa hastata* by Say, Jour. Acad. Nat. Sci. i. 65, 1817. It is abundant in bays and inlets, feeds upon putrefying animal matter, and buries itself in the sand to the eyes and antennæ. The shell is generally cast in the spring, when the animals are sought after under the name of soft crabs.

Fam. 4. *Maiidæ.* This family includes the thorny and spider-crabs, many of which have long and slender feet. The epistoma, or region between the mouth and antennæ, is large and square; the carapace is narrowed anteriorly, so as to give it a triangular outline, whence Latreille's names *Triangulares* and *Oxyrhinchi*. The front is narrow, and generally extended into a prominent rostrum; the nervous system is more concentrated than in any of the other Crustacea, and on this account it may be considered the highest group among them. They are all marine, living at considerable depths; their motions are tardy, and they do not swim. As American examples, *Leptopodia calcarata* and *Libinia comaliculata*, Say, may be mentioned. There are two sub-families: *Maiinæ* and *Parthenopiinæ*.

Class 4. *Arachnida.*

This class includes the various articulate forms known as spiders, mites, and scorpions, the characters of which place them between the Crustacea and Insecta. In general, the head is not distinct from the thorax, but intimately connected with it, forming a large segment named the cephalothorax,

which is followed by the abdomen, and this is either distinct or united in a single piece with the former. These animals are not subject to a perfect metamorphosis, but they have, in some cases, a partial one. They have neither wings, antennæ, nor upper lip; the number of feet is eight, affixed to the sternum or lower side of the cephalothorax; the mouth is provided with a pair of mandibles or *chelicera* which usually project well in front, a pair of jaws or maxillæ supporting palpi, and a lower lip. The *chelicera* are considered by Latreille not to be equivalent to the mandibles of the Crustacea and insects, but to correspond to the internal antennæ of the former, and modified into predaceous organs; a view which, if correct, would deny proper mandibles to these animals, although these organs have an important place in the Articulata as a whole. Each of the two maxillæ bears a palpus or articulated organ much like the ordinary feet, but smaller, and like the ordinary feet of the Crustacea. (See *pl.* 78, *figs.* 35–40.) In *Scorpio* (*pl.* 77, *figs.* 51, 52), the palpi are cheliform, and much larger and stronger than the feet, resembling the first pair of true feet in the crab and lobster. There is an affinity between Scorpio and the Xiphosura or genus *Limulus*, in the mandibles, which are cheliform, each ending in a pincer. The feet correspond to those of insects, the round basal portion or *coxa* being joined to the thigh or *femur* by means of a short interposed *trochanter*, the femur being followed by the *tibia*, and this by the *tarsus*, which has three articulations in the more typical forms.

The eyes are simple and smooth, and their number varies from two to eight. Their number and relative position are much used as generic characters.

The respiratory organs are of two kinds. The first (which resemble those of the Crustacea) are formed of numerous internal gills or laminæ contained in internal pouches, and answering to lungs. The second kind are composed of tracheæ or air tubes (as in insects), connected with two spiracles. Those with the former are termed *pulmonary*, and the latter *tracheary arachnidans*. Both kinds may occur united, and the *Podosomata* (*Pycnogonum*, &c.), like some of the lower Crustacea, have no means of respiration except the skin.

The abdomen is generally soft and more or less globular in form, and it bears the spiracles, anal and generative apertures (the latter being near the base beneath), and the spinnerets in those forms which spin webs. The skin is generally of a tough leathery texture, and the muscles are attached to its internal surface, thus assimilating it to the external skeleton of the Crustacea and insects.

Most of the *Arachnida* feed upon fresh animal food, as insects, which they take alive, either in their nets, or by running or suddenly leaping upon them. Some, as the ticks, are parasitic upon various animals; whilst others, as some of the mites, feed upon vegetable matter, being found in flour and figs. Some mites infest dried meat and cheese.

The *Arachnida* are mostly oviparous; the young, upon leaving the egg, are active, and resemble the adult, although some have a pair of feet less, which are finally acquired after several moultings, for, like the Crustacea, the members of this class change their integument from time to time.

The nervous system is much concentrated, being principally composed of a large ganglion in the centre of the cephalothorax, before which are two others with branches to the eyes and mouth. The principal ganglion has branches to the abdomen and feet. In the scorpions, instead of the great central ganglion, there are two rows of small ones, each united by a nervous cord.

The class is divisible into the three sections, *Aporobranchia*, for *Pycnogonum*, &c., in which there are no special breathing organs; *Trachearia*, in which breathing is effected by means of tracheæ; and *Pulmonaria*, in which the gills resemble the leaves of a book, and are adapted to breathing air only. The first section contains one, and each of the others two orders. The orders are named from the characters furnished by the body. The *Podosomata*, Leach, have the feet and body much alike; the *Monomerosomata*, Leach, have only one segment apparent; in the *Adelarthrosomata*, Westwood, the segments are uncertain; in the *Polymerosomata*, Leach, they are numerous, as in the scorpion; and in the *Dimerosomata*, Leach, including the common spiders, the body is divided into two portions.

Order 1. Podosomata. These animals are placed among the Crustacea by Milne Edwards, because they have not the organs of respiration of the Arachnida, but respire by means of the skin, like some of the lower Crustacea, a character which some of the Hydrachnidæ have, although no one would pretend to remove them to the Crustacea on this account. In form, the animals of this order approach to the crustacean genus *Cyamus* (*pl.* 78, *fig.* 24), although they have but eight feet like the Arachnida. These are long and slender, and composed of eight articulations, including the claw. The head, or rather the rostrum, is lengthened, and either cylindrical or conical, without appendages, and the mouth is terminal and tri-lobed. The thoracic portion can be distinguished from the snout, which character distinguishes them from the great mass of the Arachnida, and it is composed of four segments, followed by a small abdomen. There are four eyes upon an eminence, situated upon the upper surface of the first segment of the thorax, and as the snout does not, in the opinion of Erichson and Kröyer, comprise the whole head, this must be looked for in the first segment of the thorax, which often bears a pair of cheliform organs, corresponding, in the view of Latreille, to the cheliform mandibles of Scorpio. The female (and in some cases the male also) has attached to the first segment of the thorax a pair of appendages much like the feet (but much smaller in size, and without a terminal claw), used to support the bunches of eggs, and which may be considered maxillæ. As Erichson regards the segment next to the rostrum as the head, he names its feet a third pair of jaws, whilst Kröyer considers them feet, on the ground that the segment to which they are attached is made up of the posterior part of the head (including the eyes) united without a division to the anterior part of the thorax.

The alimentary canal is straight, and it is peculiar in having lateral tubular branches penetrating far into the feet, which dispenses with the necessity of having a regular circulation. In the more typical Arachnida, examples are found of a stomach with branches, but they do not enter the feet.

The order is widely spread, members of it having been found at Spitzbergen, the coasts of Europe and America, and Australia. Their habits are sluggish, and some of the species live together in considerable numbers. Kröyer has found that they have three stages of transformation, the body being in the first roundish or oval, without an abdomen, but with cheliform mandibles even in Pycnogonum, the adult of which is without them, a fact which indicates the little importance of these organs, and the lower condition of the forms which retain them. The third pair of feet, the segments of the body, and the abdomen, appear in an undeveloped state in the second stage; and in the third, the last pair of feet are acquired, the preceding feet have become more perfect, and the body has become longer and more like that of the adult. Another moult brings the body nearly to its final form, whilst the feet, which had diminished in length from the first to the last pair, become of equal length.

This order is not extensive, but it contains a number of genera comprised in two families.

Fam. 1. *Pycnogonidæ*, in which the feet are comparatively short, the body rather robust, and the cheliform organs wanting. *Pycnogonum* (*pl.* 78, *fig.* 32) has been erroneously stated to infest whales.

Fam. 2. *Nymphonidæ Nymphon* (*pl.* 78, *fig.* 33, inverted), in which the body and feet are very slender, and having a pair of cheliform mandibles. *N. pallida*, Say, 1821 (*Anaphia*), Jour. Acad. Nat. Sci. vol. ii. p. 60, pl. 5, fig. 7, was found on the coast of South Carolina. The expanse of its feet is one and a half, and its length one fourth of an inch.

Order 2. Monomerosomata (*pl.* 77, *figs.* 46, 47, 64–71). This order contains the small and generally microscopic spider-like animals known as mites and ticks, and to which an aerial and tracheary respiration is usually attributed, including those which are aquatic. According to Dujardin, *Gamasus* and other genera with cheliform mandibles, have tracheæ, whilst *Acarus* and *Sarcoptes* breathe through the skin. He asserts further, that in *Trombidium*, inspiration takes place by the latter mode, and expiration by the former; and that in the aquatic genera respiration takes place through spiracles scattered over the surface. The body is not divided by the separation of the abdomen as in the ordinary spiders, nor are various segments apparent as in Chelifer and Scorpio. This being the case, when the anterior portion appears to form a head, it is by the enlargement of the haustellum or parts of the mouth, the eyes being in nearly every case situated upon the anterior part of the cephalothorax. The labium or lower lip supports or incloses the organs of manducation; the palpi are usually free, of five articulations, and they present many varieties of form which are useful in classification. In some they are adapted for seizing their prey, in some for holding, and in others for drawing their food towards the mouth. The feet are usually composed of seven articulations, including the coxa (which is either attached or movable), so that they correspond with those of the Areneidæ. The extremity has usually two claws, capable of being thrown back and received into a corresponding cavity. The supposed *Acari*, with six feet, for which genera have been proposed, are the immature

condition of other genera. Dugès divides the order into seven families, the succession of which is here followed in reversed order. The genera are numerous.

Fam. 1. *Oribatidæ.* These have a remarkably hard exterior, the back being formed like a carapace, whence Hermann's generic name *Notaspis.* This carapace sometimes has a transverse division, and Dugès mentions a species in which the feet can be hidden by its lateral borders. The palpi have five articulations, of which the second is the thickest and longer than the rest conjointly. The mandibles are cheliform or didactyle, and the eyes are usually absent.

Fam. 2. *Bdellidæ.* Body oblong and tumid posteriorly, contracted behind the eyes; rostrum in the form of a head, and elongated; palpi resembling antennæ, mandibles with a claw, or cheliform; feet cursorial.

Fam. 3. *Acaridæ.* In this family the feet are carunculated, the mandibles cheliform, and the palpi indistinct, on account of their adherence along the inside margin of the labium. These animals increase rapidly, and various species infest provisions and living animals, including man. Others roam at large upon the ground, or on plants and other objects. *Acarus siro* (*pl.* 77, *fig.* 70) is the cheese-mite, which is mentioned by Aristotle. In *Sarcoptes*, the body is soft and tumid, the four posterior feet are rudimentary and provided with long bristles, the collar below and the base of the feet are armed with hooks, and the anterior feet terminate in vesicles. This genus is parasitic under the skin of various animals, including man, causing the disease named itch, and although this fact has been often doubted, it seems now to be established beyond dispute. The species which infests man has been known to the Arabs, and is mentioned by an Arabic author, Abenzoar, of the twelfth century. It has been known from time immemorial in Southern Europe, where it has been considered to be the cause of the itch, under names which are diminutives of the terms used for lice, with which they were naturally confounded in the absence of microscopic examination. Linnæus confounded this species with Acarus siro, considering the two to be varieties of a single species, a view which has been contended for in later times. It seems probable that Acarus siro is occasionally found about the itch pustules, but the Sarcoptes must be searched for at the bottom of the tortuous galleries which it forms under the skin, extending from one to six lines. The common *Sarcoptes scabiei* (*pl.* 77, *fig.* 68) is marked with curved lines above, the middle has small elevations, and there is a small bristle on each side, and two large ones posteriorly.

The itch, caused probably by different species of Sarcoptes, is spread over a great portion of the earth, and is endemic in some localities, and although it is readily destroyed, there are those who consider the irritation in the light of a luxury, and refuse to have it removed.

Various species of Sarcoptes infest man, monkeys, horses, and dromedaries. That of the last-named animal (*S. dromedarii*) is larger and better armed than the ordinary species, and in several instances it has been communicated to man.

According to Dujardin, the supposed genus *Hypopus* of Dugès, which was placed in this family, is the immature condition of Gamasus.

Fam. 4. *Ixodidæ.* The genus *Ixodes* (*pl.* 77, *figs.* 67, 71) includes the parasitic animals known as ticks. The eyes are wanting, and the body has a tough integument; their form is oval, and flat and scale-like when found among grass and bushes; but when they have affixed themselves to the animals which they infest, they become greatly distended, so that an individual a tenth of an inch long may acquire a length of one third of an inch or more by distension, when it resembles a small bean. Being very slow in their movements, they must wait long before they are afforded an opportunity to affix themselves where they can suck blood, so that the distensibility of the body and the division of the stomach into various large branches, enable them to make amends for a long fast, as in the case of the leech. The position of the animal in its parasitic state is maintained by the rostrum, which is composed of three hard corneous pieces, two above (the mandibles), their extremity armed with a movable piece margined with teeth, and one below, which is the labium. This is obtusely rounded at the end, concave above, and armed upon its lower surface with transverse rows of serriform teeth, with their points directed backwards, and recalling the somewhat similar structure in the *Acanthocephala* (p. 47), and designed for a similar use. In a state of repose, the external margins of the mandibles are clasped by the palpi, the hairs of which cover the labium beneath. The explanation of the parts of the mouth given here, is that of Dugès.

The feet in this family are robust, and have six articulations, and when the animals are among plants, and ready to attack their prey, they suspend themselves by two of their feet, extending the others to affix themselves to any passing animal. Say took *Ixodes annulatus* from a deer, and *I. orbiculatus* from a squirrel. They torment and even kill cattle when they are abundant; dogs suffer much from them, and in the West Indies they must be removed from horses and asses once a week. They also attack birds, tortoises, lizards, and serpents. They seem to be common in various parts of the world, but their distribution is local, as they are unknown in certain localities and common to others not very distant from the former. Say has described nine species inhabiting the United States, including the small and troublesome seed-tick, which renders an excursion so disagreeable in some parts of the western states. The species attack man, and cause a troublesome sore, the effects of which may continue in an occasional itching, for a period of several years.

Fam. 5. *Gamasidæ.* Palpi slender, short, free, and incurved, body depressed, eyes wanting; parasitic upon beasts, birds, reptiles, and insects. In *Gamasus* the body is oval, tough, and scutiform above, the mandibles cheliform, and the first pair of feet are slender, and the second thick. They are often seen running upon the ground, and when they are upon the animals which they infest, they run about from place to place, differing from Ixodes in this respect, and in not gorging themselves to such an extent. *Gamasus coleopterorum* has the back covered with two pale brown plates divided and surrounded by a light space. It is found in Europe and the

United States upon various Coleoptera, particularly those which live in dung. Five species are described by Say.

The genus *Argas* (*A. fischeri*, *pl.* 77, *fig.* 46; *A. savinii*, *fig.* 47) is remarkable for containing the poisonous *A. persicus*, which lives in old houses about Miana in Persia, and is said occasionally to cause the death of foreigners, although it is not fatal to the natives.

A species has been described by Guérin, which was discovered in Central America by Sallé, who states that he and his companion were awakened from profound sleep by sharp bitings or stingings, and upon getting a light he found his hands covered with blood, and swellings like large fleabites. His companion supposed that they had been stung by wasps, but upon awaking the muleteer, it was found that they had been attacked by an insect called *talaje*, and upon searching, some of the Argas were found swelled with blood, and others empty, with the skin rugose. They live in the crevices of the walls in old houses, coming out at night and returning before morning.

Fam. 6. *Hydrachnidæ.* This family includes the small globular and oval forms found in water, in which the coxæ are so broad as to form a kind of sternum. The young of *Hydrachna* are born with six feet. They swim about for some time, and then affix themselves to the bodies of aquatic insects by the anterior extremity, when the palpi and feet seem gradually to be withdrawn, and the exterior of the body becomes a kind of sac or cocoon, but the rostrum still penetrates the smaller extremity to draw nourishment from the insect to which they are affixed. The young animal leaves this skin by moulting, and attaches itself to a plant, where another moult takes place before it resembles the adult. During the period of attachment to aquatic insects, these animals can be transported by flight, and distributed to the various small detached ponds in which they are found.

The genus *Unionicola*, Hald., 1842, differs from Hydrachna in being unable to swim, in having the palpi conical, the antepenultimate articulation the longest and very thick, and the point simple, whilst in Hydrachna, as represented by Dugès, these organs are cylindrical, with a double terminal claw; the penultimate articulation is the largest, and the nails of the feet are not bifid as in Unionicola. This genus is parasitic between the folds of the mantle in the *Unionidæ*. *H. triangularis*, Say (*oviformis*, Hald.), inhabits *Unio cariosus;* it is black, and has a Y-shaped white mark upon the back. *U. reticulatus*, Hald., is pale, ochraceous, and infests *Unio viridis.* The last is a large species, being a line and a half long, the length in general hardly reaching a line. From their mode of life, it is probable that in this genus the system is oxygenated through the skin from the water.

Fam. 7. *Trombidiidæ.* This family is composed of the larger land forms, which bear some resemblance to the *Phalangiidæ* in the next order. The genus *Trombidium* is usually of a bright red, which extends over the feet and palpi, and the surface is velvety, which characteristics, together with their slow motions, will render them recognisable in the forests. The body is composed of two portions, the trunk, and an anterior and inferior portion,

including the rostrum and the four anterior feet. The larvæ have six feet, and resemble small drops of red sealing wax affixed to the legs and other parts of *Phalangium* (*pl.* 77, *fig.* 62) and various insects. These were once considered to be a distinct genus, under the name of *Leptus.*

ORDER 3. ADELARTHROSOMATA. The animals of this order respire by tracheæ, and have cheliform mandibles. They are included in the three families: *Phalangiidæ*, *Cheliferidæ*, and *Galeodidæ.*

Fam. 1. *Phalangiidæ* (*pl.* 77, *figs.* 62, 63). This family includes the slender footed spider-like animals known as harry-long-legs. The mandibles are cheliform and the palpi filiform, the eyes two, central, and near together, and the abdomen annulate and closely united to the cephalothorax. They feed upon small insects, avoid the full glare of the light, and are harmless, except that some of them have the power of exuding a disagreeable scent when disturbed. The slender feet are much like antennæ, the tarsus being in some cases composed of fifty articulations; and when the animal is standing or walking, several of the feet are held up or moved about, as if for the purpose of feeling and ascertaining the presence of objects. Some authors place the *Phalangiidæ* in one order, and the remaining families (including the *Scorpionidæ* and *Phrynidæ*) in another, under the name of *Solifugæ.*

Fam. 2. *Cheliferidæ.* The genus *Chelifer* (*pl.* 77, *fig.* 48 *a*, natural size, and 61, natural size) is remarkable for the large cheliform palpi resembling arms, which give the species the appearance of minute scorpions, except that they have not the tail of the latter. They feed upon minute animals, living in the woods or in houses, especially among books (as noticed by Aristotle), where they are rather beneficial than hurtful. They run rapidly backwards, forwards, or sideways, like the crabs; they are oviparous, have two or four eyes upon the cephalothorax, an annulate abdomen, and the eight feet are of equal size. Say describes two species inhabiting the United States.

Fam. 3. *Galeodidæ. Galeodes* (*pl.* 77, *figs.* 49, 50). The animals of this family resemble large hairy and fierce looking spiders. The palpi are long and resemble feet, and the abdomen has nine or ten articulations. The generic name *Galeodes* was proposed by Olivier, in 1791, and *Solpuga* by Herbst, in 1797, according to Agassiz' *Nomenclator*, so that the former has priority. The two terms are, however, used by Koch for different genera. The body is divisible into head, thorax, and abdomen, and the eyes are situated upon the head. The first pair of feet, as well as the palpi, are without nails, although the remaining feet have them. They run with great agility, and when interrupted they stop, raise the head, and place themselves upon their posterior feet in a menacing attitude. Lucas, who was sent by the French Government to investigate the entomology of Algeria, says, that when about to catch one of them, it leaped upon his arm and bit the sleeve, maintaining its hold until it was secured. According to Captain Hutton's observations, these animals are probably not poisonous, as a lizard bitten by one of them did not die. Another lizard three inches long, exclusive of the tail, was almost entirely devoured by one of them, which gorged it so much

that it remained motionless for fourteen days. It was nocturnal, rapacious, and was able to bite hard coleoptera into pieces. Its chief food was insects, which it masticated, and did not suck out, in the manner of spiders. They fight fiercely with each other, the victor eating the vanquished. The female watches her eggs and young with much assiduity. The latter, according to the same author, were hatched in fourteen days, and did not stir for three weeks, when they moulted and became active. Galeodes lives under stones, and digs holes for itself in the earth.

ORDER 4. POLYMEROSOMATA. In this order, which is the first of the section Pulmonaria, the body has distinct segments.

Fam. 1. *Scorpionidæ.* *Scorpio* (*pl.* 77, *fig.* 51); *Buthus* (*fig.* 52). These animals are remarkable for the articulated tail-like extension of the abdomen in the typical sub-family *Scorpioninæ*, in which the end of the abdomen is armed with a poisonous sting. The scorpions have another peculiar appendage, being a kind of comb upon each side of the base of the abdomen beneath. The eyes vary in number and position, and thus afford characters for various genera. The mouth is situated at the base of the palpi and the two anterior pairs of feet.

The extent to which the sting of scorpions is mortal, and the existence of a pore or pores to give egress to the poison, have been matters of dispute both in ancient and modern times. Pliny and Tertullian assert correctly, that it is not the wound of the sting, but the poisonous liquid, which is the cause of the evil. The poison gland opens by a pore on each side of the point of the sting. The sting of the small species seems to occasion no greater injury than that of a hornet or similar insect, whilst that of the larger species is believed to be fatal in certain cases. The Arabs, and the inhabitants generally of countries infested by the larger scorpions, regard them with horror. The sting is used in defence, and in killing the insects which are taken for food. They carry the tail curved upwards in walking. They are solitary, living in dark places, and often entering houses and taking refuge in beds, clothing, boots, &c. The scorpions are found in the warm regions of both continents; in North and South America; and two identical species are found in the Mediterranean region of Europe, Asia, and Africa.

In the sub-family, *Theliphoninæ*, the sting and abdominal combs are absent, and the abdomen ends in a slender tail.

Fam. 2. *Phrynidæ.* This family forms a link in the passage to the Dimerosomata, as the general appearance approaches that of a spider, the abdomen being oval and pedunculated, although it is segmented, and without a caudal appendage. *Phrynus*, the only genus of the family, has but six ambulatory feet, the anterior pair being very long and slender, and having all the articulations following the femur replaced by a multitude of small articulations, giving to these organs a kind of antennal character, which is observable in a less degree in *Thelyphonus*, where the tarsus alone is thus subdivided.

ORDER 5. DIMEROSOMATA. In this order, which includes the spiders, the body is divided into cephalothorax and abdomen, the latter being joined to

the former by a small peduncle. The mandibles are strong, they move vertically, or to some extent horizontally, and they have a terminal movable curved nail or tooth, which has a pore near the point through which a poisonous fluid escapes. The mandibles of the male are generally larger than in the female, although the individuals of the latter sex are usually the largest. The palpi have five articulations, and are attached to the maxillæ or jaws. They are pediform, simple, and ending with a nail in the female, and variously shaped in the male. The maxillæ vary much in shape, and afford good characters in classification. Between the maxillæ is the labium or under lip. The feet are of the same shape, but differ in length and thickness. They are usually terminated by a pair of serrated nails. There are six or eight eyes, but generally the latter number, and they are variously grouped in the different genera. The abdomen is usually soft, and sometimes very large. The generative organs are situated at its base beneath; it contains two or four spiracles, and towards the extremity are the vent, and spinnerets connected with the organs which secrete the silk.

The effect of the poison of spiders has been much exaggerated, although under certain circumstances it may be serious. Walcknaer, a voluminous writer upon these animals, states that he has caused himself to be bitten by various species, but no ill effects resulted.

Each spinneret of a spider contains a multitude of pores which, in some species, amount to more than a thousand, so that the compound thread from four spinnerets may contain four thousand strands. It has been suggested, that as the strength of a rope is increased by being composed of many separate strands, the strength of the cord of a spider is secured in the same manner; but this is an error. The strands of a rope increase its strength because the ends of the separate short fibres are thereby better secured; but the silk of the spider, being a uniform fibre, cannot be compared with a compound rope, and at best it is generally comparatively weak. The silk being in a liquid state within the body, and much being required in a short time (as when the spider descends by its thread), the extreme tenuity of the strands enables them to harden almost instantly by contact with the air. Newly born spiders are capable of spinning, and Leuwenhoeck has calculated that it would require four millions of the strands of one of them to form a thread as thick as a hair of his beard.

Some spiders shoot out long lines of silk, which have sufficient buoyancy to serve them as balloons for transporting themselves through the air. In the autumn, these gossamers are abundant in the air and on the ground, and they may be frequently seen floating in the breeze with a spider attached. Thus an individual has been observed coming across the River Susquehanna upwards of three hundred feet above the water towards a cliff of that height.

The webs of spiders are made according to various patterns. Some are closely woven into a funnel into which the spider retreats, and opening externally into a wide surface. The tube of the funnel sometimes extends into a hole in the earth, or other material. Among the webs stretched to

take flies, those formed by the large and handsome species of *Epeira* (*pl.* 77, *figs.* 53, 59) are among the most regular.

The cocoon in which the eggs of spiders are inclosed is carefully guarded. Some species seat themselves over it as if in the act of incubation, some place it in their retreats, some in their webs, and the wandering species affix it to their abdomen. In this case, if it be forcibly removed, it is sought for with great solicitude, and when found, carried off or re-affixed.

Flies and other insects constitute the chief food of spiders, and they must be taken living by the spider itself, or they will be generally rejected. Spiders are capable of fasting several months, and they pass the winter without food, being then torpid. They are eaten by various birds, reptiles, and other animals, and some of the stinging *Hymenoptera* fill the cells of their young with them for the food of the latter, being endowed with the remarkable instinct of disabling the spiders to such an extent as to render them perfectly helpless, so as to be unable to resist the young Hymenoptera, whilst they have life enough to keep them in a fresh state as long as they are wanted for food.

The spiracles are situated near the base of the abdomen beneath, one or two upon each side of the middle. When there are but two spiracles, they communicate with extremely thin laminated gills which have their extremities directed towards the aperture, so that the air can be readily admitted to them. When there are four spiracles, the two posterior ones communicate with tracheæ. The latter belong to the family *Mygalidæ* (considered a section or sub-order by some authors, under the name of *Tetrapneumones*), and containing the sub-families *Mygalinæ*, *Atypinæ*, and *Dysderinæ*. Those with two spiracles have been named *Dipneumones*. They constitute the family *Areneidæ*, with the six sub-families: *Areneinæ*, *Theridioninæ*, *Epeirinæ*, *Thomisinæ*, *Lycosinæ*, and *Salticinæ*.

The species of *Mygale* (*pl.* 77, *fig.* 58) live in holes of their own construction, some of which are closed by a trap-door, which renders them difficult to find, and affords a protection to the ingenious constructor. The trap-door is wider externally than internally, or slightly conical, and the mouth of the aperture is formed so as to receive it with great exactness, whilst the form is such as to prevent it from becoming fastened, as would often be the case were it cylindrical. This door is made of about thirty layers of silk and dirt, the layers being somewhat in the shape of small brass weights, the different sizes of which lie one within the other. Upon leaving or entering its burrow the lid closes after the spider by its own weight, and when the animal is upon the outside it must be raised to allow it to enter. The elasticity of the hinge is sufficient to close the aperture if the lid be raised vertically, or drawn still further back; and it is assisted by the distribution of the earthy material, which is thickest towards the hinge, and on this account less likely to be thrown backwards beyond its centre of gravity. Near the margin of the inner side of the lid, and opposite the hinge, the Mygale forms a series of small holes to enable it to insert its claws and jaws to hold it in place, in case of an attempt to raise the lid from without; and if a knife is inserted so as to run beneath the spider, and the

clay be then lifted with it, the deceived animal, circumvented in this unexpected manner, suffers itself to be captured without opposition. *Nemesia* (*pl.* 78, *fig.* 35).

Segestria (*S. perfida*, *pl.* 78, *fig.* 36) forms a tubular web in crevices. It inhabits Europe and North Africa.

Lycosa (*L. tarentula*, *pl.* 78, *fig.* 37 *a b c*; *L. melanogaster*, *fig.* 38) is the genus which contains the poisonous tarantula, the effects of the bite of which were supposed to be cured by music, but denied by competent Italian authority in the last century; and as far back as 1672, Doctor Cornelio, of Naples, asserted the supposed disease tarentismus to be in some cases feigned, and in others a delusion arising from melancholy. This and some allied species live in winding holes a foot or two deep. The genus *Lycosa* is common in the United States.

Argyroneta (*A. aquatica*, Linn., *pl.* 77, *fig.* 56, and *pl.* 78, *fig.* 49) is a genus of spiders with unusual aquatic habits. Breathing air, and with the structure of the land spiders, this animal lives in the water, diving beneath the surface, where it lives among aquatic plants in a kind of diving bell of its own construction, and into which it transports air from the surface. The spider, when about to carry a bubble down, bends its body, draws in its legs, and plunges suddenly, the bubble being retained by some unknown means. This is carried beneath a leaf or flat surface, and a web passed around it, thus forming a nucleus for the structure, which is gradually enlarged as bubbles are added, until it has attained the required size, when it is as large as a small walnut. It must, of course, be closed above, and the entrance must be below. If a fly is thrown into the water, the spider leaves its retreat to get it, and attaching a thread to it, drags it down. The winter is past, and the eggs laid, in this retreat. Soon after the young leave the egg, they ascend to the surface and commence taking down bubbles and constructing habitations of their own. This spider never leaves the water, but will live several days if removed from it. The single species known inhabits Europe from France to Lapland.

The bite of *Latrodectus malmignatus* (*pl.* 78, *fig.* 44) is said to be very dangerous in Corsica, being compared with that of a viper. This genus was formed from that of *Theridion* (*pl.* 77, *fig.* 55).

The species of *Tegenaria* (*T. domestica*, *pl.* 78, *fig.* 46) are found in buildings, where they live in holes, cellars, crevices, and angles of walls, in which they spin a tube connected with a broad horizontal web externally, supported by numerous lines in various directions. The web is in popular use for checking the bleeding of slight wounds, and individuals of the genus are said to have been sometimes attracted by music.

The genus *Gasteracantha* (*G. armata*, *pl.* 77, *fig.* 57 *b*) is remarkable for having an irregular abdomen armed with spines and tubercles. It is widely distributed, appearing in America, Asia, and Australia. It is allied to Epeira.

Hersilia caudata (*pl.* 77, *fig.* 39); *Chersis savinii* (*fig.* 40); *Salticus formicarius* (*fig.* 41); *Eripus heterogaster* (*fig.* 42 *a b c*); *Arcys lanceolarius* (*fig.* 43); this and the preceding one are from Brazil; *Nyssa timida*

(*pl.* 78, *fig.* 45 *a b c d e*); *Lachesis perversa* (*pl.* 78, *fig.* 47); *Uloborus walcnærius* (*pl.* 77, *fig.* 57 *a*, and *pl.* 78, *fig.* 48); *Tetragnatha argyra* (*pl.* 77, *fig.* 54).

The papers of Prof. N. M. Hentz, on the spiders of the United States, may be consulted in the Boston Journal of Natural History.

Class 5. *Myriapoda.*

The Articulata of this class bear a close external resemblance to worms, having a lengthened multi-articulate wingless and cylindrical or depressed body, and numerous articulated feet, whence they derive their scientific name as well as their common designation of centipedes and millipedes. In the *Chilopoda* (*centipedes*) there are generally one, and in the *Chilognatha* (*millipedes*) two pairs of feet to each segment, and they are usually terminated by a simple claw. In the former order they are lateral, and in the latter they are placed more towards the middle of the body beneath. In certain accidental cases, there may be three pairs of feet to an odd segment. The number of feet varies from twelve pairs to upwards of three hundred pairs.

The *Myriapoda* are terrestrial, living in dark and damp places, among moss, or under bark and stones, some feeding upon animal food, and others upon fungi, fruits, or decaying vegetable matter. They differ from insects in the nature of their metamorphosis, being born without members; but the first moult exposes the head, antennæ, and three pairs of feet, the second moult exposes seven pairs of feet towards the anterior part of the body, and finally, with the sixth moult, the full number of feet and segments is acquired, although the generative organs are not developed for two years subsequently. These facts were ascertained upon the genus *Iulus*, by Savi, a distinguished naturalist of Bologna.

Some of the species are luminous at night, at certain seasons or under certain circumstances, and some secrete a penetrating, pungent, and disagreeable material with an acid scent, although with neither acid nor alkaline qualities. Gervais ascertained that species of *Geophilus* will live a day or two in water, and that parts of the body will stir after being separated two weeks. Some species are pretty widely spread, *Scutigera coleoptrata* being found from the North of Europe to Egypt and Barbary; and it is found in the United States, where it has probably been introduced by shipping, according to a suggestion of Say.

This class is placed between the Arachnida and Insecta, by Latreille, in his last work (Cours d'Entomologie), although his opinion had varied previously. There are certain analogies between the Annelida and the Myriapoda, as in the genus *Peripatus* of the former and *Polyxenus* of the latter, the fascicular setæ of which resemble those of some of the Annelida. Their affinity to the Crustacea is observable upon comparing forms like the terrestrial genus *Oniscus*, and *Glomeris*, which has a similarly shaped body, the power of rolling itself into a ball, a crustaceous exterior, and similar

habits; and although the number of feet is fourteen in Oniscus, and thirty-two in the male and thirty-four in the female of Glomeris, the external resemblance is so striking, that *Glomeris marginatus* has often been taken for a variety of *Armadillo vulgaris.* They have also been considered to be Arachnida, and more generally, a subdivision of the true insects. Westwood, following Macleay to a certain extent, places the *Ptilota* of Aristotle (the winged insects) in one class, and the *Ametabola* in another, the latter being composed of the four orders, *Chilognatha*, *Chilopoda*, *Thysanura*, and *Anoplura.* The two first of these constitute the Myriapoda, and the last includes the lice. These heterogeneous materials are thrown together on account of their imperfect metamorphosis, a character which is indicated in the name Ametabola.

The class contains the two orders, *Chilognatha* (lip formed from the *jaws*), and *Chilopoda* (lip formed from *feet*), of which the former contains twenty-one and the latter sixteen genera, in the classification of Newport published in the Philosophical Transactions. Various species in the United States are described by Say, in the Journal of the Academy of Natural Science, vol. ii., 1821.

Order 1. Chilognatha. The genus *Iulus* may be taken as the type of this order, in which the body is slender, composed of many segments of a crustaceous consistence externally, often cylindrical, and provided with a multitude of short feet arranged in double pairs, except anteriorly, where they are single. The motion of these animals is slow, and when disturbed they generally roll themselves into a ball or spiral. The antennæ are short and slender, two in number, and have seven articulations. The mandibles are crustaceous, triarticulate, and without palpi; the generative organs are situated behind the seventh pair of feet in the male, and behind the second pair in the female. The spiracles are situated behind each pair of feet, and must not be confounded with the lateral outlets of the odoriferous glands.

The order contains the six families, *Glomeridæ*, *Polyxenidæ*, *Polydesmidæ*, *Iulidæ* *Polyzonidæ*, and *Siphonophoridæ*.

The body of *Iulus* is cylindrical, and composed of forty or more segments. The genus is common, and widely distributed in various parts of the earth. When disturbed, some of the species exude a disagreeable scent, which in the large and common species of the United States (*I. marginatus*, Say), resembles muriatic acid. This species is three inches long, blackish, and the segments have a rufous margin.

Order 2. Chilopoda. Here the body is depressed and linear, with a tough exterior, and the segments are proportionally longer, and not so numerous as in the Chilognatha. The feet also are less numerous, and the posterior pair are usually projected backwards in the manner of a tail, and used in drawing the body backwards. The antennæ are slender and tapering, and composed of fourteen or more articulations. The mouth is armed with a strong pair of curved jaws with a palpiform appendage. The eyes are usually simple, four or five on each side, or absent. These animals are nocturnal; they live upon animal food, and run rapidly.

The order includes the families, *Scutigeridæ*, *Lithobiidæ*, *Scolopendridæ*, and *Geophilidæ*.

The genus *Scolopendra* has four pairs of eyes, twenty-one segments, or twenty-two if the head is considered to be composed of two segments. In the latter case the segments may be made to correspond with the *thirteen* composing the body of insects, if the præscutum, scutum, scutellum, and postscutellum of each of the three thoracic segments, are counted separately. Under this view, the segment preceding the nine abdominal segments in *Scolopendra* will be the metathoracic postscutellum; and the posterior division of the head will be the prothoracic præscutum. A similar division of the segments appears in *Cryptops*.

The genus *Scolopendra* is widely distributed over the globe, the larger species (one of which is a foot in length) being peculiar to warm regions. Their bite is poisonous, and may be compared to that of the scorpions.

Class 6. *Insecta.*

The name of the class of Insects is derived from the *insected* or articulated structure of the body, and its frequent division into several portions, as in the Hymenoptera. It has been variously applied to portions of the Articulata, but always including the hexapod orders, which are provided with wings in most cases, and to which the term has been more and more restricted.

Insects are dioicous articulate animals, breathing air by means of tracheæ, and having a head and abdomen united by an intermediate thorax bearing the six feet and two or four wings when these are present. They have a free head bearing two antennæ, and they are subject, during their growth, to certain external and internal changes termed metamorphoses. Most insects have wings, a peculiarity which none of the other classes possess. The integument is usually sufficiently hard to serve as a kind of external skeleton, to the inside of which various muscles are attached.

The body of insects is usually considered to be composed of thirteen (sometimes fourteen) segments, which are apparent in the larva, although some of them are frequently so much reduced in size, or so intimately joined together, that they cannot be distinguished in the adult. The head forms a single segment, followed by the thorax, which is composed of three segments, and the remaining ones belong to the abdomen.

In Orismology, or the application of names to organs, it has become a matter of very great importance to apply the same name to the same part in different groups of animals, so far as this can be satisfactorily ascertained. The neglect of the older entomologists to observe a rule the advantages of which are so apparent, has been productive of much confusion, and we accordingly find the term *thorax*, which is correctly applied to the part between the head and abdomen of a *Hymenopter* (*pl.* 79, *figs.* 11, 14, 18), also employed to signify the segment next to the head in *Coleoptera*

(*pl.* 81, *figs.* 18, 23, 43, &c.). The inaccuracy of this will appear, upon reflecting that the thorax in the *Hymenoptera* bears the wings and all the feet, whilst the segment next to the head in the *Coleoptera* bears the anterior pair of feet alone, corresponding only to one third the thorax of the former. In the Coleoptera, the elytra or wing-covers, when in a state of repose, generally cover the abdomen and two thirds of the thorax, keeping the latter out of view when the insect is viewed from above. A lateral or ventral view (*pl.* 81, *figs.* 105, 106, 130) will exhibit the remaining parts of the thorax bearing the wings and the medial and posterior feet. In some cases the abdomen is entirely exposed, the elytra being so short as not to extend beyond the thorax (*pl.* 81, *figs.* 1–7). The three segments which comprise the thorax both of a *hymenopter* and a *coleopter*, may be recognised by the three pairs of feet; but whilst that next to the head (named the prothorax) is conspicuous in the latter, it is reduced to a mere collar in the hymenopter, where the next segment or mesothorax is largely developed, to bear the large anterior pair of wings, whilst the corresponding part in the Coleoptera have to bear the elytra, which are not used as organs of flight. Finally, the metathorax, or third segment of the thorax, is reduced in the Hymenoptera, the wings of this segment being small and of but secondary importance in flight, whilst in the Coleoptera the same organs are the only instruments of flight.

Most insects are oviparous; some, as *Musca carnaria*, are ovo-viviparous, the eggs being hatched within the body, and in the Pupipara the young advances to the pupa state before it is excluded, the apparent egg-shell being the pupa case.

The *egg* of insects is generally oval, but there are many other forms, as globular, hemispherical, cylindrical, lenticular, conical, pyriform, &c. The eggs of *Hemerobius* are attached to leaves at the extremity of a long thread. Some are crowned at one extremity, and others have ear-like appendages. In most cases the surface is smooth, but they sometimes occur ribbed or sculptured in various patterns. White, yellow, and green, are almost the only colors observed in them. The eggs of insects are deposited according to the wants of the young to which they are to give birth, either in earth, water, dung, upon dead animals, or in putrid vegetables, beneath the skin of caterpillars, in punctures in living vegetables, where they sometimes cause galls; some are glued to leaves or branches, and others are placed in cells where the young are fed.

The *larva* appears when the shell of the egg is burst at the period of its maturity. The name larva is applicable to the young of all insects, although those of butterflies are also named *caterpillars*, and those of certain flies *maggots*. The larva is in most cases unlike the adult insect, generally appearing as a cylindrical worm, either without feet or with six or more walking organs, of which six only are articulated feet. In this condition nourishment is taken, often in great quantities; the growth is rapid, and a series of moultings is undergone. When the larva has attained its full size, in many cases it becomes an inactive pupa without external organs, and incapable of locomotion or taking food; but when the pupa case is burst, the

perfect insect appears. In some cases the larva resembles the adult at all times in most particulars; and when, after successive moultings, it becomes a pupa, this is still much like the adult, and continues to eat and move about, differing from the larva in having incipient wings inclosed in an envelope, and from the adult in not having perfect wings. Insects are thus subject to two principal kinds of metamorphosis, whence the latter have been named *Homomorpha*, and the former *Heteromorpha*. The metamorphosis of the *Lepidoptera*, *Coleoptera*, *Hymenoptera*, and *Diptera*, is heteromorphic; whilst that of the *Orthoptera* and *Hemiptera* is homomorphic.

Heteromorphic larvæ are more or less cylindrical, with or without feet, and a distinct head. They have generally thirteen segments, each of which has been provided with a name by Newman, as follows, commencing with the head: 1, *caput;* 2, *prothorax;* 3, *mesothorax;* 4, *metathorax;* 5, *propodeon;* 6, *podeon;* 7, *metapodeon;* 8, *octoon;* 9, *ennaton;* 10, *decaton;* 11, *protelum;* 12, *paratelum;* 13, *telum.*

The head of larvæ is in some cases not different from the other segments, being equally soft, and without antennæ, eyes, or jaws. A larva of this kind (the feet being also absent) is popularly termed a maggot. The caterpillars, which have a more perfect organization, have a corneous head generally bearing the various organs apparent in the perfect insect or imago. The antennæ of larvæ have a simple structure, and but few articulations, even in those cases where the adult has them complicated and very long.

Of the two kinds of *eyes* found in adult insects, compound and simple, the latter, named *stemmata*, are alone present in the larvæ, but these are sometimes entirely destitute of visual organs. When present, there are from one to six upon each side. Some caterpillars have the power of secreting a silken thread, out of which their cocoon is made, the secreting organ being a part of the mouth. The larvæ of some Coleoptera have an analogous organ at the posterior extremity.

The sides of terrestrial larvæ generally show the spiracles, which usually amount to nine or ten upon each side. All the segments, except the first, or head, third, fourth, and last, are usually supplied with spiracles. In some aquatic larvæ there are lateral gills, and in others breathing is accomplished through the posterior extremity.

The *larva* state is that in which insects generally live the longest, the life of the imago being often very short; so short, that in some cases they require no nourishment, and are not provided with a mouth. Some species of *Melolontha* live a few weeks in the adult state, and three years as larvæ. *Cicada septendecim* (and probably other species) does not survive a single season, although its larva is seventeen years in coming to maturity.

Pupa. In the homomorphous forms the passage from the larva to the pupa state is gradual, and is accompanied by but little external change, especially in the wingless forms, as bed-bugs, and certain grasshoppers. Amongst the latter, the different stages of the genus *Phalangopsis* can hardly be determined, but we have observed that certain spines upon the legs appear only in the last stage, thus indicating the adult.

When the caterpillar incloses itself in a cocoon to take the helpless condition of a pupa, various internal changes take place, tending towards the organization of the future insect; and even previous to this, the internal organization of the larva had been gradually undergoing various changes in the nervous and alimentary systems, unaccompanied by any external change except that of size. Some pupæ are protected by a cocoon, and some are not thus protected. Of the latter, some are suspended by the posterior extremity, and others, as *Papilio*, attach themselves with the head above, and a thread around the body to maintain it in its position. Some suspended pupæ are finely marked with bright colors and golden spots, whence the name of Chrysalis, which is seldom used, and aurelia, which is obsolete.

Agassiz has pointed out several curious analogies among the classes of Articulata, composing the larvæ of Lepidoptera (particularly those with bristly tufts) to the Annelida; and the pupæ in which the abdomen alone is capable of motion (the head and thorax being united under a kind of carapace) to the decapodous Crustacea, which are, on account of this affinity with one of the conditions of insects, placed at the head of their class. He places the Insects above the Crustacea, because the former leave the condition in which they are covered by a carapace, and advance a step further. Finally, this philosophical author places the Lepidoptera at the head of the insects (as Swainson had done upon different grounds), because the larva is mandibulate, and the adult insect perfectly haustellate, so that it advances further from the larva condition than any of the orders. See Lectures on Embryology; and Proceed. Am. Assoc., Charleston, 1850.

Imago. The perfect insect or imago appears when the case of the pupa is split, and in the winged species, the wings, which were closely folded, begin to expand and take their final shape. The imago differs from the larva in having the body divided into the three principal divisions of head, thorax, and abdomen.

The integument of insects contains a peculiar principle, named *chitine* by Odier, which constitutes a third or fourth of its bulk. It resembles bone somewhat in its composition, as it contains phosphate of lime, and a trace of other compounds found in bone. The chitine forms part of the dermis, which is covered by a thin epidermis. *Coccine* is another chemical constituent, found particularly in the genus *Coccus*.

The *head* of insects is usually regarded as a single piece, but as the corresponding part in the Crustacea is considered to be made up of minor parts, it has been proposed to extend the same theory to the class under consideration, either allowing as many theoretical segments as there are kinds of appendages, or allowing two kinds of appendages to some of them. Of these two modes of viewing the question, the former is preferred in studying the Crustacea, and should therefore have the preference in this class.

The organs concerned in manducation (enumerating them from above) are, the upper lip or *labrum*, the *mandibulæ*, or upper jaws, the *maxillæ* or lower jaws, the tongue or *ligula*, and the lower lip or labium. Brullé divides the ligula into an upper organ or *epipharynx*, and a lower one or

hypopharynx, on the ground that the ligula may be superior or inferior, both portions being sometimes present, although unequally developed. If the lips and ligula be considered to be formed by the union of a right and left hand piece, they will correspond to four pairs of organs like the right and left mandibles and maxillæ, making six sets of organs corresponding to as many theoretical segments. Brullé, who proposes this theory, does not take the eyes or antennæ into account in his enumeration.

The various organs composing the mouth of insects have not the same degree of development in all, some being very conspicuous in certain cases, and obscure, modified, or obsolete in others. The distinguished Savigny, the entomologist who accompanied Bonaparte's celebrated expedition to Egypt, discovered the remarkable fact that the *antlia* or spiral sucker of a butterfly, and the maxillæ of a coleopter, are modified conditions of the same organs; and he extended this comparison to the mouth of all the orders. The *haustellum* of a fly is composed chiefly of the labium, and the *promuscis* of a hemipter of the maxillæ and mandibles.

Without attempting to divide the head of insects into theoretical segments, its various minor parts must be indicated for the purposes of reference and description. Its general form is more or less globular, with many variations, and it has projections like horns, but they are never articulated. The head (*caput*), exclusive of the attached organs, is named the *cranium;* the upper part from the front backwards, is the *epicranium;* the top of the head is the *vertex*, which is usually the seat of the *stemmata* or simple eyes; and the posterior part is the *occiput.* The anterior margin is the *clypeus*, and back of this is the *front.* The part between the eyes is sometimes named the *sinciput;* and the sides of the head *genæ* or cheeks. The principal part of the head beneath is the *gula.* The anterior part of the head is often prolonged into a *rostrum*, as in the Curculionidæ.

The *antennæ* of insects are situated upon the face near the eyes, by which they are sometimes partly surrounded, and they are attached to the head by a ball and socket connexion. These organs are generally capable of moving at the base, and the various articulations move upon each other. The articulations vary much in form and number, and afford good characters for classification. The antennæ may be shorter than the head, and more than twice the length of the body, and the number of articulations may vary from one to fifty, sixty, or more. Long antennæ are made up either of many short articulations or of a few long ones. The antennæ often differ in the sexes of the same species, in length, and in the number and form of the articulations. Among the various forms of antennæ may be mentioned the *setaceous; moniliform*, shaped like a string of beads; *serrate; pectinate; bipectinate*, with a pectination upon each side; *geniculate*, or bent like an elbow; *clavate; flabellate*, &c. Some have supposed the antennæ to be organs of feeling, others of hearing, and others of a peculiar sense, but their use is not known, and may vary in different orders.

Eyes. Insects have two kinds of eyes, compound and simple, named respectively *eyes* and *stemmata.* The former are situated upon the sides of the head, and are composed of many hexagonal lenses placed in contact,

These have been enumerated in various insects, and it has been ascertained that in the eye of an ant there are fifty lenses, in a dragon-fly twelve thousand, and in various butterflies from six to thirty thousand. The form of a compound eye is round, oval, or kidney-shaped, in the last case frequently receiving an antenna in the concavity. The eyes often nearly cover the entire head, extending upwards to bring their inner margins in contact, so that the greater part of the surface of the head has the function of a vast compound eye, as in the dragon-flies (*Libellula*). In some insects the eyes of the male cover more of the head than those of the female. Although there is usually but one eye upon each side, this is sometimes divided, as in the flat water insect of the genus *Gyrinus*, in which half of the divided eye is above and half below. In *Tetraopes* (meaning *four eyes*) the eyes have been divided by the base of the antennæ; and in some cases where they are kidney-shaped, the emargination is so deep that only a narrow strip connects the two ends of the eye. The stemmata are three (less commonly two, or perhaps even one) lenses or simple eyes, situated upon the vertex or forehead, and generally forming a triangle. The stemmata are also named *ocelli*, but as this term is also applied to spots resembling eyes (as in the wings of butterflies), the former term is preferable.

The mouth of insects, although composed of the same essential parts, has these modified into two principal types of structure, one of which is adapted to masticate, and the other to suck food. The former is termed mandibulate, and the latter haustellate, and we have the corresponding section of insects, *Mandibulata* and *Haustellata*; but in the Hymenoptera we find biting mandibles in conjunction with sucking organs.

In the *Mandibulata* the mouth organs are as follows: The *labrum*, or upper lip, is a variously shaped horizontal plate, articulated to the clypeus and covering the mandibles. The *mandibles*, or upper jaws, move laterally and horizontally, like scissors. The internal margin is sharp, and often toothed, and the apex is generally curved inwards. The *maxillæ*, or lower jaws, are situated beneath the former, and have a similar motion, but they are less robust. When fully developed, the maxillæ are composed of four or five pieces, namely, 1, the *cardo*, or hinge; 2, the *stipes*, or stalk; 3, the *squama*, or *palpifer*, closely united with the former, and supporting an articulated *palpus*, or feeler; 4, the *mando*, or *lacinia*, which forms the inside of the maxilla, and is clothed with stiff bristles. In the predatory Coleoptera its apex is curved, and often articulated, as in *Cicindela* (*pl.* 81, *fig.* 26). 5, the *galea*, or external lobe of the maxilla, which becomes a kind of second or internal bi-articulate palpus in Cicindela. In the *Orthoptera* the galea is large, and articulated at the base, and its internal side is concave, so that it approximates and protects the mando, whence its name of galea. The mando is often absent, or united to the galea, so as to form a single organ.

The *labium*, or lower lip, closes the mouth below, and although it corresponds with the upper lip, it is a much more complicated organ. In some points of view it may be compared with a pair of maxillæ united in a single

plate, as it has an articulated palpus on each side, much like those of the former organs. The labium is partly covered by and articulated with the *mentum*, which is articulated to the anterior part of the *cranium*, beneath named the *jugulum*. The labial palpi are attached one on each side of the labium near the *tongue*. The projecting sides of the tongue are named *paraglossæ*.

Thorax. The thorax supports the organs of motion, and is attached to the head of an insect by a membranous connexion. Its entire upper and lower surfaces are named respectively *tergum* and *pectum*. It is composed of three divisions, named *prothorax*, *mesothorax*, and *metathorax;* the upper surfaces of which are termed *pronotum*, *mesonotum*, and *metanotum*, and the inferior surfaces *antepectus*, *medipectus*, and *postpectus*.* The prothorax bears the anterior pair of feet, but as it bears no wings it is simpler in its structure, and its theoretical parts are more difficult to discover than those of the two other thoracic segments. It is in the latter, therefore, that we must look for the subdivisions of these segments. These are generally enumerated from the front backwards, when the four subdivisions of the upper part will be the *præscutum*, *scutum*, *scutellum*, and *postscutellum*, and those below, the *paraptera*, *sternum*, *episterna*, and *epimera*. The term *pleura* is applied to the sides in descriptions, but it is not limited to any particular part. The *sternum* is the chief central part with which the two *episterna* articulate, and the two *epimera* are near the insertion of the feet, and the *paraptera* (or *tegulæ*, or *patagia*) near the wings. Newport thinks it exists in a rudimentary condition in the prothorax, but Straus Dürckheim thinks the part referred to by that author is the rudiment of another segment. The mesothoracic scutellum is often seen wedged between the base of the elytra in the *Coleoptera* (*pl.* 81, *figs.* 23, 124, 131, &c.) The prothorax and mesothorax have usually each a pair of spiracles, but in the *Hymenoptera* the second pair is upon the metathorax.

The chief appendages of the thorax are the feet, which are never absent. These organs have many modifications to adapt them to their various uses of walking, swimming, grasping, leaping, digging, &c. The thoracic cavities into which the base of the feet is fitted are named *acetabula*, and the basal part of the limb which enters them is the *coxa;* but this is sometimes firmly attached, so as to have no independent motion. Next to the coxa follows a small articulation named the *trochanter;* then follows the principal articulation, the *femur*, or thigh, to which succeeds the *tibia*, which is often armed at the end with fixed or movable spines, named *calcaria*. This part is more generally provided with spines and cilia than the other parts. The tibia is followed by the tarsus, which is made up of several small articulations named *phalanges*, of which there are never more than five. The end of the tarsi is usually armed with two claws named *ungues*.

* *Prostethus, &c.*, would be more uniform with *prothorax, &c.*, than *antepectus.* The name *prosternum* cannot be used with propriety, as it is applied to a minor division (sternum, episterna) of the breast of each thoracic segment.

Insects which have five articulations to the tarsus are named *pentamerous.* Those with four are named *tetramerous;* but as a fifth immovable and microscopic articulation has been discovered, Burmeister names this form *cryptopentamerous*, and Westwood, *pseudotetramerous*, a useless addition of names, for, as Mulsant observes, the terms *Tetramera*, &c., refer to the number of *free* articulations. Solier goes so far as to consider all the Coleoptera pentamerous; but even could the abortive articulations be detected, the relation of the different groups would not be altered, because the tarsi of the Pentamera would still have five, and those of the Tetramera four movable pieces. In the *Heteromera* the four anterior tarsi have *five*, and the posterior pair *four* articulations. *Trimerous*, *dimerous*, and *monomerous* tarsi are also enumerated. The anterior tarsi are sometimes wanting, as in Ateuchus.

The wings, when present, are either two or four, the anterior pair being affixed to the mesothorax, and the posterior ones to the metathorax. Sometimes the two pairs are equal, and when they are of unequal size, sometimes the anterior ones are the largest, as in the Hymenoptera and Lepidoptera; and sometimes the posterior ones, as in the Orthoptera. In the Coleoptera the anterior wings are converted into *elytra* for the protection of the true wings, not being used as organs of flight. The wings are composed of two usually transparent membranes, between which various hollow nervures are distributed, and filled with air from the body. In the Orthoptera (grasshoppers, &c.) the upper or anterior wings (named *tegmina*) are thicker and narrower than the inferior ones, and the latter are folded like a fan. In a part of the Hemiptera the base of the upper wings has a leathery texture. All the wings of the Hymenoptera, Lepidoptera, and Neuroptera, are of a uniform texture respectively. Those of the Lepidoptera are covered with minute scales; those of the Neuroptera have numerous reticulating nervures, and in the Hymenoptera the nervures are but few. In the Diptera, or flies, the anterior wings are used in flight, the posterior ones being reduced to a small knobbed thread (*halteres*). In the *Strepsiptera* the posterior wings are fully developed, the anterior ones being abortive. In most of the orders of winged insects there are genera and species which have no wings; and some have wings in one sex and not in the other, as in the female coleoptera, known as glowworms. In one genus of Orthoptera the posterior wings are present, without a vestige of the anterior pair.

Abdomen. The abdomen is attached to the metathorax, either by its entire breadth, or by a portion of it only. The upper surface is named the *dorsum*, and the lower one the *venter.* Of the nine distinct normal segments some are occasionally absent by a union of several into one. In some cases the segments of the dorsum and venter do not correspond; in Carabus, for example, the former has nine and the latter but five. In many cases the abdomen of the male has one segment more than that of the female, and the dorsum has generally one more than the venter. The connexion between the upper and lower parts of the same segment, and between the segments, is effected by a membrane, and in the latter case the base of each segment slides within the preceding one. The abdomen is more

capable of motion than the thorax, and in some insects it is very flexible, as in the coleoptera with short elytra, the wasps, &c. The abdominal spiracles are situated at the junction of the dorsum and venter, or in the lateral margin of the dorsum, and nearly every segment has a pair of spiracles. The abdomen has various appendages, as the forceps in the male of Panorpa, hooks, stylets, ovipositor, sting, &c.

The *nervous system* of insects corresponds with the articulate type, being composed of a double cord with a line of ganglions. The principal organ of circulation is a dorsal vessel, which is a long muscular pulsating heart. The alimentary canal offers many modifications to adapt it to the various kinds of food upon which insects subsist.

Many insects, particularly the Coleoptera, are luminous at night. Among these are members of the genera Elater and Lampyris. In both sexes of certain species of the former genus, the light is emitted chiefly from a raised oval spot on each side of the pronotum, but the sides of the abdomen are luminous also. The light is sufficient to enable a person to read small print, if the insect be passed along the lines. In Lampyris the light proceeds from the posterior extremity of the body, and it is more bright in the female (which is sometimes apterous) than in the winged male. The larvæ of some of the Lampyrides are luminous, and in the southern United States there is a small flat larva (probably of an Elater) about an inch long, which emits a strong phosphorescence from all the segments, equal to that of Elater noctilucus; and when the head and tail are brought together, a brilliant circle, like a ring of diamonds, is formed. According to Kirby and Spence, the eyes of some nocturnal Lepidoptera are luminous. In several North American species of *Sphinx* we have observed eyes apparently phosphorescent, by dim candlelight, or when shaded from its direct light; but this false phosphorescence has always disappeared when the light was extinguished, so that in these cases, at least, there was only a peculiar reflection.

Many insects imitate the possum in simulating death when disturbed; some allow themselves to drop from leaves; elaters, when unable to escape by running, either simulate death, or by a click throw themselves out of the way. The genus *Brachinus*, when disturbed, shoots out a vapor accompanied by a slight sound. Some insects defend themselves by biting, some by stinging, some by ejecting acrid matter from the stomach and mouth, and others by exuding a disagreeable scent. The caterpillars of the genus *Papilio* project, when disturbed, a forked gland from the neck above, which is the seat of a very offensive odor. The spinous tufts of some caterpillars have an irritating quality like that of nettles.

Sounds are emitted by various insects, and by means of various organs, as the rubbing together of the wings in Orthoptera, the end of the abdomen against the inside of the elytra, and the prothorax against the mesothorax. The male *Cicada* makes a very loud and shrill sound, which is produced by a peculiar apparatus opening at the base of the abdomen. The vibrating apparatus is lateral, and the mirror-like membranes within the external aperture may be destroyed without interrupting the sound. A nocturnal

butterfly, *Acherontia atropos* (*pl.* 80, *fig.* 15), produces a plaintive cry, which is said to proceed from the head. We have discovered that a sound is made by an American species of *Lithosia* (another nocturnal lepidopter) by vibrating the sides of the thorax; and we have heard a very low and dull musical sound from the hemipterous genus *Belostoma* (*pl.* 80, *fig* 71), produced apparently by a vibration within the thorax, and from the lowness of the note produced, a large portion of the organs must be concerned in producing it.

The relations of insects to man are more numerous and important than those of the other classes of animals excepting the domestic breeds, and they exceed these in the importance of their history. Almost every year new enemies to the various vegetable productions cultivated by the farmer and gardener make their appearance, the history of which must in many cases be known before the proper means can be taken to prevent their increase. Often the noxious insect has a destroyer in some other insect, and the latter, being seen about the infested vegetable, is often mistaken for the real enemy. Some insects destroy the leaves and blossoms of plants, as the larvæ of butterflies; the larvæ of some *Coleoptera*, especially those of some of the beetles (*pl.* 81, *fig.* 130), are very destructive to the roots of grass, which they sometimes destroy to such an extent that the sod can be taken up in large flakes. An instance is related of a farmer whose crops were entirely destroyed by the larvæ of *Melolontha* (*pl.* 81, *fig.* 130), of which eighty bushels were collected. At one time the cultivation of the sugar cane had to be abandoned on account of the increase of an ant (*Formica saccharivora*), which destroyed all the plantations; and on the eastern continent large tracts are sometimes rendered desolate by the ravages of the large grasshopper, *Locusta migratoria*. The *Curculionidæ* (including the weevils) (*pl.* 81, *figs.* 67–76) are destructive to various kinds of grain and seed; the *Cerambycidæ* (*pl.* 81, *fig.* 50, &c.) destroy growing and dead wood; *Bostrichus*, &c., perforate the bark; and the Aphides and other families suck the sap; so that amongst the various orders, all parts of a plant, from the root to the seed, whether living or dead, are subject to destruction.

Insects are frequently useful to plants in bringing the pollen to the pistils, and thus securing the continuance of the species in cases where this could not be effected except by such extraneous means. The insects which feed upon honey and pollen effect this object, not only in cases where the stamens and pistils, although together, present difficulties in the mode of getting the pollen to the latter, but in those cases where the plants are dioicous, when it sometimes happens that the staminate and pistillate flowers are several miles apart. Moreover, the stamens and pistils often arrive at maturity at different periods in the same blossom, so that the ripe pollen is carried upon the hairy body and limbs of the insect to the mature pistils of a different tree.

The predaceous insects are useful in destroying those which feed upon vegetables, and they attack both the perfect insects and their larvæ. The parasitic families destroy an immense number of caterpillars, and the larvæ

of flies which destroy vegetables, and their size is so graduated that they are capable of destroying larvæ of all sizes, from those several inches in length, to such as do not exceed one twenty-fifth of an inch.

Insects in their various states constitute the food of many beasts, birds, reptiles, and fishes. Some, as the large grasshoppers, are sometimes dried and eaten in the Levant; some savage nations eat the large grubs found in rotten wood; and the *cossus*, which the ancients esteemed as a great delicacy, was a larva of some kind, and an allied one is now eaten in Brazil. Ants are eaten by the savages of Brazil, the formic acid probably replacing the vinegar used in civilized gastronomy; whilst some of the lowest savage tribes devour their own vermin.

The various species of blistering flies are employed under the name of *cantharides;* the genus *Coccus* furnishes the beautiful dyeing material cochineal; the galls formed on oak trees by insects of the genus *Cynips*, are used in the arts; and insects furnish honey, silk, and manna.

Caprification is an art which has been practised from a remote period. It consists in causing figs to ripen by suspending upon the trees branches of the wild fig tree (named *caprificus* by the Romans), which is infested by an insect which pierces the fruit and causes it to ripen.

The indigenes of Brazil have made a curious surgical application of ants, many of which, when they attack with their mandibles, will allow themselves to be pulled to pieces rather than let go. When one of these natives has received a cut, the sides of the wound are brought together carefully, and an ant adapted for the purpose is made to bite the conjoined edges, when the body is torn from the head, the process being repeated according to the length of the wound, so that the natives are often seen with rows of ant heads upon various parts of the body.

Although insects are essentially terrestrial, there are families, the members of which swim upon the surface (as *Gyrinus*), or walk with the body raised above it (as *Gerris*, or *Hydrometra*), the tips of their feet touching the surface, and a few which walk upon the bottom (as *Nepa*). These are almost entirely confined to the fresh waters. Westwood, however, describes a genus (*Micralymma*) which inhabits the coasts of the sea between high and low water mark, under such circumstances that it must remain four hours under water at each tide, and he mentions other instances of Coleoptera remaining beneath salt water for shorter periods. (Mag. Zool. and Bot. ii. 124.) According to Audouin, a small carabideous insect, *Aepus fulvescens*, passes a great part of the time beneath the sea, holding a small quantity of air among the bristles with which it is in part clothed; but whether it can abstract oxygen from the water when this is exhausted, has not been determined. It is probable, however, that this power exists in the coleopterous genus *Elmis*, and some allied ones, the species of which are small, tardy in their movements, and unable to swim. They live affixed to stones at the bottom of fresh waters, which are sometimes so rapid that the insects could not reach the surface and return to the position in which they are found.

Among the insects which walk upon the water, the most remarkable is the genus *Halobates* (allied to *Gerris*), which is found far at sea in the

Southern Atlantic and the intertropical regions of the Pacific. Most of the species have been described from wingless individuals, probably larvæ.

Orders of Insects.

The distribution of insects into orders has been one of the chief problems of Entomology, and one about which there is a great want of unanimity. Latreille, the father of modern Entomology, who was born in 1762, and devoted a long life to the science, proposed a system in 1796, which he subsequently modified in various editions of his works, in 1806, 1817, 1825, 1829, and 1832. In these he adopted the following arrangement of the orders, which is still very generally followed:

A. Insects without wings.	
a. Without metamorphosis.	
* Mouth mandibulate, . . .	1. THYSANURA.
** " suctorial (lice), . . .	2. PARASITA.
b. A metamorphosis (fleas), . . .	3. SIPHONAPTERA.
B. Insects with wings.	
a. Elytroptera,	
(Anterior wing acting as a sheath for the posterior one.)	
* Mouth mandibulate,	
Wing-covers horny, metam. perfect, . .	4. COLEOPTERA.
" " " " imperfect, .	5. DERMAPTERA.
" " coriaceous, " " . .	6. ORTHOPTERA.
** Mouth suctorial, " " . .	7. HEMIPTERA.
b. Gymnoptera (wings alike).	
* Wings four.	
† Mandibulate, mandibles distinct.	
Wings reticulated, ...	8. NEUROPTERA.
" veined, ...	9. HYMENOPTERA.
†† Mouth suctorial, mandibles abortive, .	10. LEPIDOPTERA.
** Wings two.	
† Two twisted halteres before the wings,	11. RHIPIPTERA.
†† Halteres two, behind the wings, . .	12. DIPTERA.

It must be borne in mind that the same name is in some cases not given to the same group by different authors, and that the same order sometimes has several names. The English authors exhibit a fondness for numerous orders, separating, for example, the Cicadæ from the Hemiptera, under the name of *Homoptera.*

After various modifications, Burmeister proposed, in 1839, a very different arrangement, founded principally upon the metamorphosis, of which he admits two grades, one half, the other entire, according to which he names insects *Hemimetabola* (*Ametabola* of Leach) and *Holometabola* (*Metabola* of Leach), each of which contains haustellate and mandibulate orders, of

which the former contains two: 1, *Rhynchota;* 2, *Gymnognatha;* and the latter four: 3, *Antliata*, Fabr. (*Diptera*, Linn.); 4, *Piezata*, Fabr. (*Hymenoptera*, Linn.); 5, *Glossata*, Fabr. (*Lepidoptera*, Linn.); and 6, *Eleutherata*, Fabr. (*Coleoptera*, Linn.). For all these, except the second, Burmeister adopts the names of Fabricius. The peculiarity of this arrangement is the reduction of the orders to six, and the distribution of the minor parts of each, as will be observed in the following sketch.

The *Rhynchota* are made to include the tribe and family *Pediculina* (the lice), or haustellate *Anoplura;* whilst the mandibulate *Anoplura*, or bird lice, form the second tribe of his order *Gymnognatha*, under the name of *Mallophaga*, the first tribe being the *Physopoda*, from which Haliday and most English entomologists form their order *Thysanoptera*. The order *Thysanura* of preceding authors forms a *tribe*, next to which succeed the *Orthoptera* (including *Blatta*); *Dermatoptera* (*Forficula*, *pl.* 81, *figs.* 1–3); *Corrodentia* (*Termes*, *Embia*); *Subulicornia* (*Ephemera*, *Libellula*); *Plecoptera* (*Semblis*); *Trichoptera;* and *Planipennia* (*Sialis*, &c.), all as *tribes* of the same order. It results from this, that the *Neuroptera* and *Orthoptera*, as well as other groups usually considered orders, form but one order, in the opinion of Burmeister. Erichson (in Agassiz's Nomenclator) places the *Thysanura* as an order, except that the *Lepismidæ* are withdrawn and placed in the order *Orthoptera*, which is further enlarged by the addition of the *Libellulidæ*, which are abstracted from the remaining *Neuroptera*. Erichson admits the orders *Thysanoptera*, *Epizoa* (lice), and *Suctoria* (fleas).

Burmeister states the principle upon which he establishes his orders as follows: "The more marked the transformation the more heterogeneous is the individual in the several stages of its existence; and as all insects proceed from the same point, those necessarily, whose metamorphosis we call complete, must attain a higher grade than the rest, which transform themselves incompletely. We thus obtain two chief groups among insects, *Hemimetabola* and *Holometabola*. Both commence a new development in the organization of the mouth, as they at first exhibit to us abortive, setiform, oral organs, only adapted to suction, but in the higher grades these suctorial organs develope themselves into free mandibles, with a lip covering them. Thus each group has *Insecta haustellata* and *Insecta mandibulata*. Each of these groups may then be further subdivided, according to the form of the larva, the structure of the wings, and the entire internal organization, and these divisions constitute their orders. We thus obtain an arrangement, the principles of which are deduced from the idea of the entire insect, and which, as this idea becomes separated according to its several characters and constituents, it consequently necessarily and spontaneously forms itself by the philosophical laws of thought."

The orders of Latreille will be chiefly followed here, not because they are considered to be correct, but because the accuracy of the modifications proposed by Erichson and Burmeister has not been sufficiently tested. Moreover, the views of these celebrated entomologists do not correspond.

Order 1. Thysanura (*pl.* 77, *figs.* 79–84). In this order, established by

Latreille in 1796, and considered a tribe of his order *Gymnognatha* by Burmeister, the body is apterous, more or less cylindrical, and often covered with minute scales like a silvery dust. The antennæ are longer than the head, and the mouth is provided with mandibles and maxillæ. They are of active habits, living in woods, among moss, or beneath stones and bark. Some of the small species are sometimes found on the surface of the water near the margin, or hopping about on the surface of snow in winter, sometimes in great numbers. The order contains the two families, *Poduridæ* and *Lepismidæ*.

Fam. 1 *Poduridæ*. Here the body is oblong or globular, the antennæ are rarely composed of more than four articulations, but in the genus *Macrotoma* the three or four articulations are divided into a great many rings or indistinct segments, indicating an affinity with the Lepismidæ. The palpi are indistinct according to some authors, and absent according to others. The mandibles and maxillæ are membranaceous, the eyes simple, varying in number, and the abdomen is four or six articulate. The prothorax is sometimes much reduced in size, or wanting above, although a part of it remains below, to which the anterior feet are attached. The posterior extremity is provided with a spring or appendage bent along the abdomen, and used in leaping. This, however, is wanting in the genus *Anura*, in which the mandibles and maxillæ seem to be absent. They are usually confined to damp places, and die very soon if deprived of moisture. The oral aperture is so minute that it is supposed they subsist upon the juices of decaying vegetable matter.

Podura (*pl.* 77, *fig.* 79 *a*, natural size; *b*, magnified, exhibiting the caudal spring). *Smynthurus* (*fig.* 80) has the abdomen large and globular. The species of this genus are often seen hopping upon the surface of water and snow. The dark-colored species of this family are so abundant at times as to give the snow the appearance of being sprinkled with course gunpowder. J. M. M'Minn mentions their occurrence in the mountains of Pennsylvania, in the following words (Proceed. Acad. Nat. Sci. iv. 246): "I have frequently noticed them in mid-winter on the snow, but I never saw such a multitude of them together as I witnessed on the 17th of Feb., 1849. The snow was entirely covered for the fourth of a mile along the road, and several rods on either side. The mercury in Fahrenheit was standing about fifteen degrees; the atmosphere was dry and clear. These little animals were quite stupid, and to all appearance had been but a short time there, and as it was about nine o'clock in the morning, I judged that they arrived at night. Their motion was slow, and those on the top were quietly endeavoring to get under. The next day, when I again passed the spot, I could not detect a vestige of them. The wind had been strong from the north for several days, and I have noticed that we had strong north winds whenever I had seen them." This species is probably the *Podura nivicola* described by Dr. A. Fitch, who gives a similar history of it in his account of the "Winter Insects of Eastern New York," published in the Am. Jour. of Agr. and Sci. for May, 1847.

Fam. 2. *Lepismidæ*. In this family the antennæ are setaceous, and

composed of a great number of small articulations; the oral organs are present, the palpi are conspicuous, and each side of the abdomen has a row of movable appendages, which Latreille considers false feet, and Gervais respiratory organs. The abdomen is composed of ten segments, and terminated by a number of multi-articulate threads, which vary in number according to the genera. The genus *Machilus* (*pl.* 77, *figs.* 81, 84) has a leaping spring like Podura, and a large compound eye formed by the fusion of the two which appear in other genera. The genus *Lepisma* (*figs.* 82, 83) is found in houses in Europe and America, and from the silvery color of its scales, it is sometimes called sugar-fish. It runs rapidly, and is difficult to take without removing the scales. The common species is supposed to eat sugar, whence its name *Lepisma saccharina.*

ORDER 2. ANOPLURA. The order *Anoplura* (thus named by Macleay from the absence of locomotive caudal appendages) was also named *Parasita* by Latreille, on account of its parasitic habits, and *Epizoa* by Nitzsch, from its occurrence upon animals. In this order, which includes the lice, there are six feet, no wings, and two or four stemmata. Burmeister, as we have already seen, places the two families of which it is composed in separate orders, one, the *Pediculidæ* or lice, among the *Hemiptera*, and the *Nirmidæ* or bird lice among the *Orthoptera*, the former being haustellate and the latter mandibulate. The general structure and habits of the two families are very much alike, and we have seen that the best characters, as those afforded by the organs of respiration, are in certain cases not uniform throughout an order; so that in the present case the difference between the oral organs of the two families may be of no more account than the absence of special respiratory organs in some of the Crustacea. The head and thorax are distinct, the antennæ are short, and composed of but few articulations; the tarsi have but one articulation, terminating in a simple nail, sometimes doubled back, so as to form a claw adapted for holding.

Fam. 1. *Pediculidæ.* The mouth is a small suctorial retractile rostrum placed beneath the head. The thorax is narrower than the abdomen, which is large, and with the segments (of which there are from seven to nine) distinct. There are six pairs of spiracles. This family contains several genera, of which the best known is *Pediculus. P. capitis* (*pl.* 77, *fig.* 77, *a b c*) infests the human head. The eyes are a black point on each side, the antennæ have five articulations, and the general color is pale yellowish, with a dark line on each side. The skin is tough, and sufficiently translucent to exhibit the internal organs. Lice multiply rapidly with warmth and moisture. Leeuwenhoek, by keeping a male and female in his stocking, which he wore day and night, ascertained that one of them might increase to five thousand in eight weeks. They are found chiefly on children and dirty persons, more frequently upon the back of the head, and the use of hair powder is favorable to their increase. They are easily destroyed by various mercurial ointments, or an infusion of *Cocculus indicus.* The louse which infests negroes is a distinct black species with a large flat head. *Pediculus vestimenti* (the clothes louse) is a second species which is found

upon the back and breast, and in the clothing of unclean persons. It is more slender, with a thinner neck than *P. capitis*, and its eggs are attached to the hair of the breast and arms. It is common upon the lower classes in Russia and Spain. *P. tabescentium* infests the body also. It resembles *P. capitis* and *P. vestimenti*, but is a little larger, the head round, the thorax quadrate, the abdomen ending with four bristles, the antennæ rather long, and the color pale yellow. It inhabits the human body in the folds of the skin, and is found in connexion with the disease named Phthiriasis. It forms small scale-like flaps of the skin, beneath which it is found, particularly upon the back, breast, and neck. Among those who have died of this disease were Antiochus Epiphanes, Herod, Plato, the emperor Maximian, and the poets Alcmanus and Ennius. Burmeister thinks this species has a spontaneous origin in the corruption of the fluids in old or enervated subjects. He states that it is not contagious, as a woman of seventy who occupied a bed with her husband did not communicate it to him. This case was cured by the application of oil of turpentine. Cleanliness is of no avail, new lice being in some cases produced until the death of the patient. See Burmeister's Manual of Entomology, English ed., p. 307, § 203; and Kirby's Bridgewater Treatise, chap. 1. The human race is attacked by still another and smaller species of parasite, which differs so much from the former one, as to constitute a distinct genus named *Phthirius* (*P. pubis*, *pl.* 77, *fig.* 76). The body of this species is short and wide, and the thorax much wider than the head. It infests the axillary and inguinal regions.

Fam. 2. *Nirmidæ.* These insects are chiefly found infesting birds, and are familiarly termed bird lice. The head is generally large and triangular, rounded in front, and often with pointed projections; the mouth is beneath; the labrum, labium, mandibles, and maxillæ are present, the last being in most cases minute, and either with or without palpi. When the palpi are present, they have four articulations. These insects do not feed upon blood, but the feathers upon which they are usually found seem to supply them with food. A bird may have from one to five species of these lice; and the same species sometimes inhabits several distinct birds, but in general certain forms are confined to certain orders and families of them.

The genus *Trichodectes* of Nitzsch belongs to this family, and is found upon Mammalia, as the dog, cat, weasel, bear, porcupine, horse, ox, sheep, deer, &c. *Gyropus* also infests Mammalia. The most useful single work upon this order is Denny's Monographia Anoplurorum Britanniæ, London, 1842, 8vo., with 26 colored plates.

Order 3. Siphonostoma. This name was proposed for the fleas (*Pulex*, and several allied genera) by Latreille, in 1825; Kirby and Spence named them *Aphaniptera*, in 1826; Degeer named them *Suctoria*, 1778; and some restrict the term *Aptera* to them. The mouth approaches nearer to that of the higher *Diptera*, with which order they have the greatest affinity, and in which they would probably be placed by Burmeister. Fleas are parasitic in their perfect state, infesting man, beasts, and birds. The body is compressed, with a tough shining integument, and transverse rows of bristles. There are no wings, but these organs are represented by two scales on

each side. There are two stemmata; the mouth is provided with a tongue, two lancet-shaped palpi, and a pair of long slender mandibles with serrulate edges. The maxillary palpi have four articulations, and are so long that they resemble antennæ (the antennæ being inconspicuous), and below these there are two maxillæ, shaped like triangular plates. The antennæ are minute, situated behind the stemmata, and capable of being hidden in a cavity. The feet are long and bristly, and adapted for leaping, and the tarsi are pentamerous. The larva of the flea is a slender white active grub, without feet, but it is provided with antennæ, and a pair of posterior hooks. It attains its full size in about twelve days, when it spins a silken cocoon, and becomes a quiet pupa, in which the limbs of the imago are visible.

Fleas (*Pulex irritans*, *pl.* 77, *fig.* 73 *a b*) abound where there are dogs and hogs; in camps and barracks, where they often swarm in the quarters of the soldiers. The larva seems not to be parasitic, living upon the litter of stables, &c. They are often produced from eggs laid under the toenails, or in the seams of the drawers of uncleanly persons, where they find nourishment adapted to their wants.

Pulex penetrans (*pl.* 77, *fig.* 72 *a b c d*), the type of Guérin's genus *Dermatophilus*, is a small species which lives parasitically beneath the skin of the feet of men and dogs in the warm parts of America, particularly Guiana and Brazil. It is known as the jigger (chegoe, chigo), and by a dozen other names. It is found in sandy places, where it hops about like the other species, until it finds a suitable resting-place, when it penetrates beneath the skin and forms serious sores. In this condition the abdomen of the female enlarges to the size of a small pea (*fig.* 72 *c*, enlarged and inverted), and is found to be full of eggs. The male has not been observed, and is probably not parasitic. They frequently lodge in the toes, especially beneath the nails, causing great pain and inflammation, and it sometimes happens that the toes must be amputated, in consequence of the sores to which they give rise. Waterton saw the foot of a negro which was a mass of ulcers from the neglected attacks of this insect. According to this author, "The Indian and Negro wenches perform the operation of extracting chegoes with surprising skill. They take a pin, and by a very slow process, they lay the part bare, and contrive to work quite round the bag which contains the chegoe and its offspring. As soon as this has been effected, they turn the bag out, whole and uninjured; by which means none are left in the hole to form a new colony." Besides man and dogs, the sand flea attacks sheep, goats, cats, hogs, oxen, horses and asses. According to Azara, it does not extend beyond 29° of south latitude.

Order 4. Coleoptera (*pl.* 81, *figs.* 84–148). This order includes all the insects with thin membranous wings on the metathorax, covered by hard coriaceous wing-covers or elytra attached to the mesothorax, their color and texture having more or less resemblance to the general exterior surface of the body. The mouth is mandibulate, and the wings folded transversely to allow them to be withdrawn beneath the elytra. There are, however, exceptions to most of the characters by which groups in the animal kingdom are defined. The wings, and even the elytra, are sometimes wanting. The elytra, which unite in a

straight line along the dorsum, lap the one over the other in a few cases; and in others they are connate, or soldered together into a single piece, there being no wings beneath them.

The *galea* of the maxillæ in the *Orthoptera* is rarely represented in the *Coleoptera*, and when it is, the form is entirely different; and the wings are neither formed nor folded as in that order. The head, thorax, abdomen, and feet, are distinct, and the prothorax is a conspicuous part, capable of motion, and allowing the head to move upon it. The eyes are generally two in number, and stemmata are extremely rare. In rare cases the eyes are absent. The mouth is composed of a labrum, mandibles, maxillæ, and labium, with their appendages. The antennæ and parts of the mouth are extremely variable, and afford characters for genera and higher groups.

The abdomen is attached by its entire base; beneath it is more or less hard, but above it is membranous, being protected by the elytra. *Coleoptera*, with a few exceptions, do not fly with the ease and rapidity of some of the other orders, and they do not take wing so readily, it being necessary first to raise the elytra and extend the wings; but in the *Cicindelidæ* and some other families, this is done with remarkable quickness.

The head and prothorax are often ornamented by horn-like projections, sometimes resembling jaws, as in (*pl.* 81, *fig.* 148) *Scarabæus hercules*, in which the upper projection is from the pronotum, and the lower one from the head; and *Oryctes nasicornis* (*fig.* 145) has a horn arising from its head resembling that of a rhinoceros. The sexes are distinguished in various ways in the different groups, as by the antennæ in some, and the feet in others. In some genera, as *Lucanus* (*fig.* 124), the mandibles are much larger in the male than in the female, and of a different form. This order is oviparous, the male dies soon after pairing, and the female after depositing her eggs. In cases where the male has not paired, it has been preserved alive for a period much beyond that of its ordinary life.

The *Coleoptera* have been studied more than any other order of insects. the causes of which may be stated as follows. With the exception of the *Lepidoptera*, they contain the handsomest species. The *Lepidoptera* are difficult to take in a perfect condition, and when taken they require more attention in carrying and handling, and in expanding the wings, besides taking up more room in cabinets, and being more likely to be destroyed by moths and other destructive larvæ. Coleoptera present great variety in their structure; their exterior hardness renders their preservation a simple matter. It requires but little trouble to collect and bring home a great many at a time, and they can be easily caught and collected when insects which are more upon the wing are not seen. There are more books upon the Coleoptera, which facilitates their study and renders it more easy to discover new species.

In forming a collection of Coleoptera (and these remarks will, in most cases, apply to other orders), various localities must be sought. Many frequent the blossoms and leaves of shrubs and trees, various species are found in rotten wood, dung, carrion (*Necrophorus* prefers dead reptiles), beneath stones, logs, bark, or under the earth. Species which live in fungi

may be readily taken by making a pile of this material and looking through it in the course of a day or two. Some species which live in moist places, or beneath the sand along the margins of water courses, can be driven from their retreats by dashing up water with the hand. Hosts of small species are found amongst the grass, from which they may be swept with a canvas net attached to a stout wire ring twelve or thirteen inches in diameter, and fixed in a handle about two feet long. The canvas and fixtures must be sufficiently strong to allow briers and other rough vegetation to be swept without injury to it. A great many species are attracted by a light at night. When captured, Coleoptera (and other insects which are not readily injured) should be put into small short vials in which a little paper has been put to allow them to cling to, but predaceous ones should be put into a bottle with a little ether in it, as they would destroy the others. For the smaller kinds a bottle must be provided with a quill (to be closed with a stopper) inserted through the cork, through which they are to be passed into the bottle, to prevent the inmates from escaping when a new prisoner is to be added. These may be killed by having a little paper in the vial moistened with ether, or by immersing the whole in hot water.

Each specimen should have a pin of a suitable size passed vertically through the *right* wing cover, to within less than half an inch of the head. When an insect is too small to have a pin passed through it, this must be stuck through the large end of a small triangle or wedge of thin card, about one fourth of an inch long, and one sixteenth of an inch wide at the large end, the opposite end being pointed. Upon the upper surface of the point of this card, small insects must be gummed, and in such a position that the pin being vertical and upon the right, and the point of the card towards the left side, the insect must cross it at right angles, the right elytron being towards the pin, and the abdomen towards the manipulator, and this position must be preserved in the cabinet. The gum used must be gum arabic, with a little starch and inspissated ox gall, this being indispensable to prevent the gum from flying with the extremes of temperature, and it is sufficiently adhesive to prevent insects from being jarred loose by touching the pins. The same material is to be used in mending insects. The pins used for the small cards should be small No. 1 of the German manufacturers, and in general thin pins should be preferred. When insect pins cannot be procured, the ordinary kinds may be used, but in this case a great many specimens must be attached to cards. If pins are subsequently procured, the carded insects may be placed for a few hours in a closed vessel of moist sand, when they can be detached, and will be sufficiently relaxed to allow them to be pinned without breaking the antennæ and feet.

Specimens are to be arranged in horizontal rows on the drawers of a cabinet, made with every joint close. The drawers for the Coleoptera of the United States may be from twenty to twenty-four in number, of a size to allow a glazed cover to each, of ten by twelve inch glass, the frame of which should both enter about half an inch within, and project over the edge of the drawer on the four sides, to give double security to the joint. This frame should be carefully fitted before the drawer is put in. The

bottom should be smoothly covered with sheet cork, corn-stalk pith, the soft root of the southern tupelo, or the wood of *Agave americana*. If soft white pine is used, a small hole must be made with an awl before a specimen can be inserted. The depth of the drawers will depend upon the length of the pins used. The German insect pins are 1⅜ inches long, and are preferable on account of their toughness and elasticity, in which they excel the English and French pins. The pin that holds the insect will also pass through the label. A piece of camphor wrapped in gauze or other thin material should be placed in one corner of every drawer, and should it be found from the dust beneath a specimen that there is an enemy at work within it, it should be removed and subjected to a heat nearly equal to that of boiling water. This may be done by placing it in a covered tin vessel, which may be immersed in another containing hot water. A good wash to destroy moths and the various larvæ found in collections, is composed of one part of oil of turpentine, and six of camphorated alcohol. A few globules of mercury are sometimes placed in the drawers to prevent the ravages of the minute louse-like *Troctes pulsatorius*. Constant care is necessary to prevent collections from being destroyed, and new specimens should be introduced with great caution, as they may contain eggs which will produce a destructive larva.

Much of the history of insects remains to be known, and larvæ should be drawn and described, and kept until their final change shows what they are. By a system of numbering, valuable observations may be made without a knowledge of the scientific name of an insect. This knowledge comes slowly, and the observer should not relinquish his studies because he meets with difficulties. New discoveries are made every year in Europe, whose entomology has been long studied by numerous active observers, and still more important ones would reward a similar class upon this continent, where so much remains to be made known in the various orders of insects.

Coleoptera are widely spread, the largest species being found between the tropics. They seem not to be as hardy as some of the Neuroptera and Diptera, none being found in Spitzbergen and similar localities. The richest collection of Coleoptera is that of the Royal Museum of Berlin, which contains 40,000 species.

Various classifications of the Coleoptera have been proposed, not one of which has acquired an exclusive popularity. Here we follow that of Westwood, which agrees better with the arrangement of Stephens and Latreille, than with that of Erichson, which will probably supersede them in time.

The order is divided into *sections* (Westwood Shuckard), according to the joints of the tarsi, which, although they are not uniform in every case, afford a remarkably good general characteristic. This gives the four sections, *Pentamera*, *Heteromera*, *Tetramera*, and *Trimera*. Macleay divides the Pentamera into two groups (named *tribes* by Westwood), *Chilopodomorpha* and *Chilognathomorpha*, according as the larva resembles Scolopendra and Julus; and he endeavors to divide the remaining sections in an analogous

manner according to the forms of the larvæ. There is a discrepancy in Mr. Westwood's nomenclature of the Tetramera, of which he admits the three ordinary groups, but applies to them the name of sub-sections, which he does not apply in the other sections. The tribes are divided into groups termed *sub-tribes* by Westwood (*sub-division* by Shuckard, and *section* by Stephens), and each division of the sub-tribe is named *stirps* by Westwood and Stephens (and *tribe* by Shuckard). These divisions may be tabulated as follows:

Section.	*Tribe.*	*Sub-tribe.*	*Stirps.*
Pentamera,	Chilopodomorpha,	Adephaga, . . .	Geodephaga. Hydradephaga.
		Rypophaga, . . .	Philhydria. Necrophaga. Brachelytra.
	Chilognathomorpha,	Cordylocerata, . .	Clavicornia. Lamellicornia.
		Serricornia, . . .	Macrosternia. Aprosternia.
Heteromera,	Thysanuromorpha,	. . . .	Trachelia.
		Atrachelia, . . .	Irisomata. Melasomata.
Tetramera,	Helminthomorpha, ...		Rhyncophora. Longicornia.
	. . . .		Phytophaga.
Trimera,	Anoplurimorpha, ...		Scaphisomata.

The *Coleoptera* of the section *Pentamera* have five articulations to each tarsus, and they are the most perfect and the most numerous members of the order. In some of the *Hydradephaga* and *Brachelytra* the tarsi are anomalous, and in the latter there are dimerous forms, and such as have four articulations to the anterior and medial feet, and five to the posterior ones. Latreille divides the Pentamera into six families, *Carnassiers*, *Brachelytra*, *Serricornia*, *Clavicornia*, *Palpicornia*, and *Lamellicornia*. The first corresponds to the *Adephaga* of Clairville, which include the predaceous land and water families, the former being the *Geodephaga*, containing the two families *Cicindelidæ* and *Carabidæ;* and the latter the *Hydradephaga*, with the two families *Dyticidæ* and *Gyrinidæ*.

The *Adephaga* have slender antennæ and a palpiform bi-articulate galea to the maxillæ in addition to the ordinary maxillary and labial palpi. The maxillæ have a row of stiff bristles along the inner margin, and the apex armed with a hook.

Fam. 1. *Cicindelidæ*. In this family the antennæ are slender, the apex of the maxillæ is in most cases a movable tooth bent inwards, and in the male the anterior tarsi are usually wider than in the female. These insects are of a moderate size, often of brilliant colors, the head and eyes rather

large, the mandibles strong, pointed, curved, and toothed, and all the organs of manducation and locomotion well developed. They inhabit hot and sandy localities and dusty roads, running rapidly, and when disturbed, taking wing with great facility, and alighting again at a little distance. They are very ferocious, and prey upon other insects. Among the genera, *Cicindela* (*pl.* 81, *figs.* 26–29) is the most abundant and the best known. Between forty and fifty species of the United States are known, for descriptions of which, Say's paper in the Trans. Am. Phil. Soc., vol. i., 1818; and that of Dr. J. L. Le Conte in the Annals of the N. Y. Lyceum of Nat. Hist., may be consulted. The name *Cicindèla* (accented on the third syllable) is sufficiently well known to prevent names like soldier bug, or Spanish fly, from being applied to them.

Fam. 2. *Carabidæ* (*pl.* 81, *figs.* 11–16). This family corresponds very nearly to the genus *Carabus*, as viewed by Linnæus. It is allied to the preceding, but the terminal tooth of the maxillæ is hardly ever movable, the mandibles have in general the predaceous structure less developed, and the head is generally narrower than the prothorax. These Coleoptera are predaceous, feeding upon insects, but a few feed also upon vegetable food. They are numerous in genera, species, and individuals, and they abound in cold and temperate regions. Many of the species are less than an eighth of an inch in length. They inhabit fields, where they feed upon larvæ and insects, and they constitute a majority of those found under stones and rubbish. They are generally nocturnal, although some, including the subulipalpi, are diurnal, with habits much like those of the Cicindelidæ. Many of the species have a fetid odor, and exude an acrid liquid when disturbed.

The second stirps, *Hydradephaga* (*Hydrocanthari*, Latr.), have the posterior and middle feet flattened, and margined with a bristly fringe, adapting them for swimming, and the posterior pair is distant from the medial feet. The body is oval and depressed, sometimes subglobular, the head broad, and the mandibles robust. There is much less variation of form, and fewer genera and species among them than appear in the Geodephaga; and the forms from different countries and climates present but little variety, even in color. Of the two families, the *Dyticidæ* have long antennæ and short anterior feet, whilst the *Gyrinidæ* have the antennæ short and the anterior feet long. The former swim beneath the surface, coming up occasionally to breathe, and the latter swim in circles upon it. These insects swim with great facility, and prefer lakes, ponds, or standing water. Like the Geodephaga, they are predaceous, both in their larva and perfect state. They seldom leave the water except to find another locality, and then they prefer flying by night.

Fam. 1. *Dyticidæ*. *Dyticus* (*D. marginalis*, *pl.* 81, *fig.* 17) includes certain large species which are destructive to young fish, larvæ, and worms. They are very hardy, and may be sometimes seen in small pieces of water, when the surrounding parts are covered with ice. In some of the members of this family the elytra are smooth in the male and sulcate in the female, and in some males the three basal articulations of the anterior tarsi are enlarged and furnished with little organs like suckers.

Fam. 2. *Gyrinidæ.* Here the antennæ are short, and of eleven articulations, the eye of each side is divided into two parts by the sides of the head, and the posterior and middle feet are flat and very short. They swim in circles upon the surface of the water, sometimes in great numbers, and when disturbed they dive with great facility. Like the preceding family, they are sometimes active in winter; and one species, according to Westwood, has been found upon Mount Etna in the region of perpetual snow.

The second sub-tribe *Rypophaga* (or cleansers) have the antennæ clavate, or thickening towards the apex, two labial and two maxillary palpi, the galea represented by the exterior maxillary lobe, which is generally dilated, and sometimes jointed, seldom palpiform. There are three stirpes, *Philhydria*, *Necrophaga*, and *Brachelytra.*

The *Philhydria* partake of the aquatic habits of the Hydradephaga, living along its moist margins. They have the body short, and convex above, the abdomen covered by the elytra, the hind feet formed for swimming or walking, the mandibles small, the maxillary palpi with four articulations, and the outer lobe generally articulated. The *Philhydria* contain the six families: 1, *Heteroceridæ;* 2, *Parnidæ;* 3, *Helophoridæ;* 4, *Hydrophilidæ;* 5, *Sphæridiidæ;* 6, *Agathidiidæ.* The first are the *Acanthopoda*, the second the *Macrodactyla*, and the third, fourth, and fifth, the *Palpicornia* of Latreille.

In the fourth family, *Hydrophilidæ*, the body is ovate or hemispherical, and adapted for swimming or walking upon subaquatic objects. The prothorax is narrowed anteriorly, and the feet are compressed. They are generally of dull tints, they prefer stagnant waters, and some are found in those that are brackish. Some of those which swim have the trasi of the four hinder feet fringed with long hairs. *Hydrophilus* (*pl.* 81, *fig.* 18) is a genus of large Coleoptera, with the sternum ending posteriorly with a long spine, the antennæ of nine articulations, and shorter than the maxillary palpi. In swimming, the feet are moved alternately, giving a less rapid motion than in the predaceous families; and being vegetable feeders in their imago state, they have no need of great locomotive powers. The female has a posterior pair of organs for secreting a cocoon to contain the eggs. This is nearly an inch in diameter, and is composed of fine white silk interiorly, with a gummy coating which hardens, and is impervious to the water. It is affixed to floating aquatic plants. It is formed in about half an hour, and the extremity of the abdomen serves as a mould upon which to form it. The eggs, to the number of fifty or sixty, are inclosed in a regular upright position, and the young escape below where the aperture is very slightly closed.

The second stirps, the *Necrophaga* of Latreille, have the body depressed, the elytra often abbreviated, the apex of the antennæ thickened, the mandibles generally prominent, the maxillæ with a double membranous extension, the outer lobe slender, rarely articulate, the maxillary palpi with three articulations, or with the basal articulation minute, and the feet ambulatory. These insects feed upon, and thus remove dead carcases; some remove decaying fungi in the same manner, and some feed upon the exuding juices of

plants. The families, according to Westwood, are: 1, *Scaphidiidæ*; 2, *Silphidæ* (*pl.* 81, *fig.* 104); 3, *Nitidulidæ* (*fig.* 102); 4, *Engidæ*; 5, *Paussidæ*; 6, *Mycetophagidæ*; 7, *Dermestidæ*. Stephens places the *Erotylidæ* here also, but with the exception of the tarsi, their affinities are with the *Trimera*. In rare cases in the *Mycetophagidæ*, the tarsi are tetramerous and heteromerous.

In the *Silphidæ* the body is depressed, the antennæ clavate, with eleven articulations of which the terminal four or five form the head. The genus *Necrophorus* (*pl.* 81, *figs.* 105, 106) is remarkable for finding the carcases of small animals soon after death, burying them by working the earth from beneath them, and afterwards covering them. The female deposits her eggs in these buried carcases.

The larvæ of the *Dermestidæ* destroy animal matter, especially dried skins. *Dermestes lardarius* is well known, from its attacks upon stores of beef and pork; and *Anthrenus* is very destructive to the various animal objects preserved in museums. In their perfect state, the *Anthreni* are found upon flowers.

The *Brachelytra* (*pl.* 81, *figs.* 4–6) form the third stirps of the sub-tribe *Rypophaga*, and are distinguished by the elongated form of the body and the shortness of the elytra (which seldom cover half the abdomen), and beneath which the wings are closely folded. The antennæ are generally slightly thickened towards the apex, the mandibles are robust and seldom exserted, and the abdomem is flexible, and often raised over the back in running. They run and fly with great facility, and in their habits are allied both to the *Carabidæ* and to the other *Rypophaga*. They live about dead animal and vegetable matter, or in damp localities, and some of them eat larvæ and other living food. The habits of the adult and larvæ are the same, and they do not differ much from each other, which indicates a low position in the living scale. According to Westwood, this group should be considered a family under the name of *Staphylinidæ*, although it is usually divided into a number of so-called families. Most of the species are small, and require a good microscope and a good manipulation to study them properly. Westwood states the sub-families to be the six following: 1, *Staphylinides*; 2, *Stenides*; 3, *Oxytelides*; 4, *Omaliides*; 5, *Tachyporides*; 6, *Pselaphides*. In the last group there are only three articulations to the tarsi, one of which is so small as to have been at first overlooked, so that they were considered dimerous, and formed into a primary section named *Dimera*. They are from two to four millimetres long, and are found under stones, in meadows, and in ants' nests. Dr. J. L. Le Conte has published an interesting memoir on the North American species.

The *Cordylocerata* of Westwood constitute the third sub-tribe of the *Pentamera*, and include the stirpes *Clavicornia* and *Lamellicornia*. The stirps *Helocera*, the name of which is adopted from Duméril by Stephens, is named *Clavicornia* by Westwood, a term under which Latreille included the *Necrophaga*.

The *Clavicornia* have the body short, sub-globular or sub-quadrate, the antennæ clubbed, the basal articulation often forming half the entire

length, and the sternum in some cases hiding the mouth below. The feet are compressed, and can be drawn close to the body, which has generally cavities to receive them. This stirps contains the two families *Byrrhidæ* and *Histeridæ*. *Hister* (*pl.* 81, *figs.* 119–128) is the chief genus of the latter family, in which the body is sub-quadrate, often widest in the middle, of a hard consistence, mostly black, marked with striæ and punctures, the disposition of which affords good specific characters. The elytra are somewhat shorter than the abdomen, the antennæ are elbowed, and the mandibles strong and projecting. When disturbed, they draw up the feet, withdraw the antennæ into cavities beneath the thorax, and simulate death. They are found in carrion, dung, and decaying fungi. The genus *Hololepta* is very flat and scale-like, and the species are found beneath moist bark. The American species, *Hetærius brunneipennis*, Randall (*Hister*), is found in ants' nests. The paper of Major John Le Conte on this family may be consulted in the Boston Jour. Nat. Hist.

The stirps *Lamellicornia* is extensive and contains numerous distinct forms. The distinctive character is in the antennæ, which are short, of nine or ten articulations, the last (generally three) forming a club composed of flat plates closing upon each other like the leaves of a book. The anterior tibiæ are generally dentate. The males often differ from the females in having large mandibles and horn-like projections. This stirps contains the largest and some of the handsomest and most splendid among known insects. Some feed upon pollen and honey, some upon leaves, and many frequent excrementitious and decaying vegetable substances. The larva is a long fleshy grub, generally white, curved in a semicircle, having six feet, little capable of locomotion, and generally living in the ground. The families are: 1, *Lucanidæ* (*pl.* 81, *fig.* 124); 2, *Geotrupidæ* (*fig.* 143); 3, *Scarabæidæ* (*figs.* 132, 136–142); 4, *Aphodiidæ* (*figs.* 133–35); 5, *Trogidæ;* 6, *Dynastidæ* (*figs.* 145–8); 7, *Rutelidæ;* 8, *Anaplognathidæ;* 9, *Melolonthidæ* (*figs.* 129–131); 10, *Glaphyridæ;* 11, *Cetoniadæ* (*figs.* 125–127).

The *Lucanidæ* (*Lucanus*, *pl.* 81, *fig.* 124) are considered by Westwood and others to form a group equal in value to the remaining families united, named respectively *Priocera* and *Petalocera* by Duméril. The American *Passalus cornutus* belongs to this family. Its larva is white, and presents the remarkable peculiarity of having but four feet, the posterior pair being represented by a small scale upon each side, which can be moved rapidly, as if it were a real foot. It is found beneath the bark of rotten logs, and is not bent in a semicircle, but walks freely upon its inferior surface. The adult burrows in rotten wood, and may be recognised by its shining black color, large size, flattened parallel form, and quadrate prothorax separated from the striate elytra. The strongly elbowed antennæ in this family indicate an affinity with the *Histeridæ*.

The *Scarabæidæ* (*pl.* 81, *figs.* 132, 136, 140–144) have the front of the head extended into a flat clypeus used in working in the ground, and in the dung upon which they feed. Many of them form a ball of dung (said to contain the eggs) which one or two of them roll along until they have found

a suitable place, when they commence working the earth from beneath it, and gradually burying it. The American *Canthon læve* (or *C. volvens*) generally works in pairs, one pushing the ball backwards with its hind feet, its posterior extremity raised up, the other walking up the ball on the opposite side, thus causing it to roll. The ball is about three fourths of an inch in diameter, and quite globular. *Copris carolina* makes a small ball, which it buries at once. *Deltochilum gibbosum* of the southern states makes a small ball, in the exterior of which there is a great deal of cow's hair. The genus *Ateuchus* (*pl.* 81, *fig.* 132) entered largely into the mythology of the ancient Egyptians, and models and figures of it are common among Egyptian antiquities. In *Lethrus cephalotes* (*fig.* 144), a European insect, the pronotum and elytra nearly correspond in size and convexity, the feet are long, and inserted near each other, and the antennæ terminate in a reversed cone.

The *Aphodiidæ* (*figs.* 133–5) are small oblong insects found in dung, some of which are black, and some of brighter colors. They may be seen flying slowly along the roads in the warm days of autumn. The elytra cover the entire abdomen.

The *Dynastidæ* include some of the largest Coleoptera, as *Dynastes hercules* (*fig.* 148), *D. acteon* (*fig.* 147), *D. alsoëus* (*fig.* 146), *Oryctes nasicornis* (*fig.* 145). During the day they live in the earth, or in the decomposed matter of old trees, and fly about at night. *Scarabæus tityus*, of the United States, is found in old apple trees. In general, the male alone has the horn-like projections.

Melolonthidæ. *Melolontha vulgaris* (*pl.* 81, *fig.* 131), *M. fullo* (*fig.* 130), *Rhizotrogus* (*fig.* 129), *Serica* (*fig.* 126), are examples of this family, which is important in its relations with agriculture.

The *Cetoniidæ*, of which *Cetonia* (*pl.* 81, *fig.* 125) and *Trichius* (*fig.* 127) are examples, contain some of the handsomest of known insects. They feed upon the fluids of plants, as honey and sap, and also upon parts of the blossoms.

The *Serricornia* constitute the fourth sub-tribe of the Pentamera, and include many handsome forms of vegetable feeders, in which the antennæ are generally short, and serrate, pectinate, or filiform, the apex rarely thickened. The form is lengthened, and the elytra generally cover the abdomen. They include the two stirpes, *Macrosternia* and *Aprosternia*.

The *Macrosternia* (*Sternoxi* of Latreille, *pl.* 81, *figs.* 22, 23) contain the genera *Buprestis*, and many more having the same general characters. They are included in the three families, *Buprestidæ*, *Eucnemidæ*, and *Elateridæ*.

The *Buprestidæ* include a great number of brilliant, large, and medium species resembling gold or precious stones. The body is hard, cylindrical, flattened, elliptic or oval, the feet short and weak, the elytra narrowed towards the end, the wings adapted for a rapid flight, the head vertical and deeply inserted in the prothorax, which is attached by a wide surface to the mesothorax, so that there is but little motion between these parts. They are chiefly inhabitants of warm climates, and the size of the species varies

from a line to two and a half inches. *Buprestis mariana* (*fig.* 22), to which this generic name properly belongs, is much like the North American *M. virginiana.* *Fig.* 23 represents *Euchroma gigas*, which inhabits Cayenne. The larvæ in this family bore in wood, and may be frequently discovered under the bark of pine logs.

The *Elateridæ* (*pl.* 81, *figs.* 30–33) are closely allied to the *Buprestidæ*, but the colors are not so brilliant, and the body is less hard. The chief difference is in the structure of the prothorax, which moves so freely in a vertical direction that the insect can employ this power to throw the body about, either to regain its position upon its feet or to escape. The prosternum has a projecting spine, which fits into a corresponding impression in the mesosternum. They are generally found among living vegetables. We have found the larva of the large North American *Alaus oculatus* in the wood of ash trees. This species extends from the northern part of the United States to the latitude (19°) of Vera Cruz in Mexico.

The *Aprosternia* (or *Malacodermia*) have the antennæ generally long and serrated, sometimes clavate, and not lodged in a groove of the prosternum, the head deflexed and deeply seated, the body elongate and generally soft, and the feet rather long and slender. The greater part of them are winged. The larvæ feed either upon wood or insects, and the adults are found upon flowers or plants, in dead wood, or upon the earth. Some are predaceous. The *Malacodermes* of Latreille include the families *Cebrionides*, *Lampyrides*, *Melyrides*, *Clairones*, and *Ptiniores;* but Stephens and Westwood extend the group considerably further, and the latter adds the family *Scydmænidæ*, which Stephens places with the *Heteromera.* With this exception, the families of these two authors agree, and are as follows: 1, *Cebrionidæ;* 2, *Cyphonidæ;* 3 *Lampyridæ;* 4, *Telephoridæ;* 5, *Melyridæ;* 6, *Cleridæ;* 7, *Ptinidæ;* 8, *Lymexylonidæ;* 9, *Bostrichidæ;* 10, *Scydmænidæ.*

The *Lampyridæ* are well known as the family containing the fireflies and glow-worms. The body is lengthened and depressed, and with the elytra of a soft consistence, and the head is more or less hidden by the prothorax. Most of the species seem to be carnivorous. When disturbed they draw in their members and simulate death. The common glow-worm of the middle United States is the female of *Photuris versicolor.*

In the *Melyridæ*, some of the species of *Malachius* are remarkable for having red lateral organs which they can swell or relax at pleasure, the use of which is not known. The species of this genus feed upon insects.

In the *Cleridæ*, the larva of the genus *Clerus* is remarkable for destroying the larvæ of bees. *Necrobia* and *Corynetes* are found about old animal carcases, particularly upon the bones.

The family *Ptinidæ* contains various small oval insects with the head placed deep in the prothorax, the antennæ eleven-articulate, filiform, or sometimes pectinate. They are of obscure colors, and counterfeit death. They are very destructive to the woodwork of houses and furniture, and some destroy books and collections of dried plants and insects. The genus *Anobium* sometimes strikes its jaws upon the wood in which it

has its station, in such a manner as to imitate the ticking of a watch.

Lymexylon, the type of the family *Lymexylonidæ*, is very destructive to ship timber in the dockyards of Europe.

The *Bostrichidæ* have a hard cylindrical body, a deeply seated globular head, clavate antennæ, strong mandibles, and the pronotum projecting over the head, and often scabrous. They live in timber, boring holes in the wood and bark.

With few exceptions, the section *Heteromera* have four articulations to the posterior tarsi, and five to the others. They are generally vegetable feeders, and differ much in their habits. Some live upon plants, and are variously colored; others live in dark places, and are of obscure colors; and some, which are allied to the latter, are found in desert plains. Latreille divides this section into four groups, named *Melasoma*, *Taxicornia*, *Stenelytra*, and *Trachelides*. Westwood divides them into three stirpes, *Trachelia*, *Varicolores*, and *Melasomata*. The *Trachelia* (*Pyrochroa*, *pl.* 81, *fig.* 40) are an extension of Latreille's group *Trachelides*, and contain a number of active insects, with the body and elytra soft. They are found upon plants, and are generally of bright colors. The head is enlarged behind the eyes, and the antennæ are slender and branched.

Westwood indicates the following families in his tribe *Trachelia:* 1, *Notoxidæ;* 2, *Pyrochroidæ;* 3, *Lagriidæ;* 4, *Horiidæ;* 5, *Mordellidæ;* 6, *Meloidæ;* 7, *Salpingidæ;* 8, *Oedemeridæ;* 9, *Melandryidæ.*

There is a good deal of confusion in the names of several genera of *Heteromera*, on account of an endeavor to set aside names which should stand on the ground of priority. Linnæus, the inventor of the modern nomenclature, applied certain ancient names, as *Cicindela*, *Buprestis*, and *Cantharis*, to insects, without caring particularly to what insects they were applied by the ancients, and properly, because with the ancients these were worthless vernacular names; and as we do not go either to Pliny or to a modern retailer of drugs to learn entomology, we have no particular interest in knowing the names objects bear with them.

With Linnæus, the blistering flies formed a part of his genus *Meloe*, and he formed a genus, *Cantharis*, in 1735, for an insect to which Schæffer applied the useless synonym of *Telephorus*, in 1766. In 1764, Geoffroy properly separated the blistering flies from *Meloe*, assigning to them the name *Cantharis* of the druggists, which he had no right to do, that name being already applied to a genus, so that it was virtually without a name until Fabricius, in 1775, rectified the blunder of Geoffroy, by naming the blister flies *Lytta*, a name adopted by Dejean, Say, Erichson, and others.

Many of the *Meloidæ* have the power of raising blisters when applied to the skin, and different species are used for this purpose in different countries. In *Meloe* (*pl.* 81, *fig.* 7), one of the elytra laps over the other at the base.

The tribe *Atrachelia* have the head enlarged and deeply set; they are in general dark-colored, living in dark places, and running slowly upon the ground. A few of the families are bright-colored, and are found upon

flowers. The families are: 1, *Cistelidæ;* 2, *Helopidæ;* 3, *Diaperidæ;* 4, *Tenebrionidæ;* 5, *Blapsidæ;* 6, *Pimeliidæ.* Of these, the three first are variously colored, and constitute Westwood's sub-tribe *Varicolores.* The remaining three are black or obscure, and constitute the *Melasomata* of Latreille.

The *Tenebrionidæ* are well known from the meal bug (*Tenebrio molitor*), the round hard larvæ of which, as well as the perfect insect, are found in flour, sea-biscuits, &c., upon which they feed.

The *Blapsidæ* of the United States occur in the region of the Rocky Mountains, whence they extend to Texas.

The insects of the section *Tetramera* include those Coleoptera which have four movable articulations to all the tarsi. They are very numerous, and all of them are vegetable feeders, both in the larva and perfect state. They are divided into three stirpes, of which the *Rhincophora* have the head produced into a rostrum, and the antennæ generally short and elbowed. The *Longicornia* have long antennæ and an oblong body; and the *Phytophaga* have a short round body and short antennæ. There are many beautiful insects among the Tetramera, but except among the Longicornia, they are generally less than an inch long.

The *Rhincophora* (*pl.* 81, *figs.* 65–76) are numerous in species, of which about 8000 have been described in the great work of Schœnherr. The mouth is situated at the end of the rostrum, which is sometimes very slender, and as long as the rest of the body. The insects known as weevils, which are destructive to various kinds of seeds, belong here, and the seeds of a great many vegetables are attacked by peculiar species. The elytra are often connate, or united in a single piece, and with the exterior parts, they are often so hard that it is difficult to stick a pin through them. Some are beautifully marked with brilliant minute scales, which are favorite objects for viewing with the microscope. The English have named several of these *diamond beetles*, on account of the appearance of these scales. The divisions of Rhincophora by Schœnherr are here given, from the fifth volume of his *Genera et Species Curculionidum*, 1839. It will be observed that his use of the words *order*, *family*, &c., is peculiar to himself.

SUB-FAM. 1. GENUINI.

ORDO I. GONATOCERI. Antennæ geniculate, basal articulation received into a groove in the side of the rostrum.

LEGIO 1. BRACHYRHYNCHI. Rostrum short and robust. Divisions (Phalanx 1): *Brachycerides*, *Entimides*, *Pachyrhynchides*, *Brachyderides*, *Cleonides*, *Molytides*, *Byrsopsides;* (Phalanx 2) *Phyllobides*, *Cyclomides*, *Otiorhynchides.*

LEGIO 2. MECORHYNCHI. Rostrum cylindric, lengthened, with the antennæ between its base and middle. Divisions: *Erirhinides*, *Apostasimerides* (sub-divisions: *Cholides*, *Baridides*, *Cryptorhyncides*), *Conophorides*, *Cionides*, *Rhyncophorides*, *Cossonides.*

Ordo II. Orthoceri. Antennæ not geniculate, basal articulation not very long, and not received into a groove in the rostrum. Divisions: *Tanaonides*, *Ithycerides*, *Camerotides*, *Antliarhinides*, *Attelabides*, *Belides*, *Apionides*, *Ramphides*, *Cylades*, *Ulocerides*, *Oxyrhynchides.*

Sub-fam. 2. Spurii.

Legio 1. Palpi hidden, very short, antennæ geniculate and clavate, tarsi pentamerous. Division: *Dryophthorides.*

Legio 2. Palpi hidden, antennæ straight, not properly clavate, tarsi indistinctly pentamerous. Divisions: *Oxycorynides*, *Brenthides.*

Legio 3. Palpi exserted and filiform, tarsi distinctly tetramerous. Divisions: *Rhinomacerides*, *Anthribides*, *Bruchides.*

Schœnherr excludes the *Scolytidæ* from the *Rhynchophora*, and Westwood places them at the end of them. They include various genera destructive to forest trees.

The *Longicornia* (*pl.* 81, *figs.* 44–60) have the antennæ long and tapering, generally as long as the body, and not clavate; the eyes generally reniform, and the body elongated. The head is sometimes horizontal and sometimes vertical, the front generally impressed, the prothorax varying, being convex or flattened, transverse, globular, cylindrical; spinose, nodulous, or smooth; presenting in *Acrocinus* a movable spine (umbo) on each side. The feet are generally slender, the tarsi clothed with short hair beneath, and the third articulation cordate. Some of the females have an ovipositor to insert the eggs in the bark of trees. They are graceful in form, and many of them are brilliantly colored. Some run and fly with great facility, whilst others are tardy in their movements. Some are deprived of wings and confined to the ground and low shrubs. Some frequent flowers and other forest trees, and the larvæ of the latter are often destructive to useful trees. The beautiful American *Clytus pictus*, a species marked with yellow lines like *fig.* 51, is very destructive to locust trees, in the branches of which the larva bores. It also destroys young hickory saplings which have been cut for hooping casks.

The larva of *Oncideres cingulatus* lives within the dead branches of hickory, eating the dead wood; and to supply it with this food, the female deposits the eggs in little perforations which she makes in the bark towards the end of the branches, which she kills, by gnawing a groove entirely round, through the bark and into the wood, which effectually accomplishes the object. The dead branch retains its position long after the dead insect has left it. The upright stem is often thus attacked, when a lateral branch shoots forth to supply its place, which may be similarly attacked the next year, and this sometimes happens for four or five years in succession, so that the top of a young hickory tree sometimes presents a curious and mutilated appearance.

There are three families of Longicornia: *Prionidæ*, *Cerambycidæ*, and

Lepturidæ. Among the genera figured in plate 81, are *Prionus* (*fig.* 61), *Clytus* (*figs.* 51, 52), *Astynomus* (*fig.* 54), *Saperda* (*fig.* 56), *Leptura* (*fig.* 46), *Molorchus* (*fig.* 45). In the last the elytra are very short, and the wings are not folded under them. Serville is the chief authority in the arrangement of the Longicornia. For the species inhabiting the United States, the papers of Say, Haldeman, and Le Conte, may be consulted.

The *Phytophaga* is an extensive group of short and often polished and bright colored insects which inhabit and feed upon plants, and many of the species are destructive to garden vegetables. Latreille divided them into *Eupoda* (from the size of the posterior feet) and *Cyclica* (from their circular form). The families are: 1, *Sagridæ;* 2, *Crioceridæ;* 3, *Cassididæ;* 4, *Galerucidæ;* 5, *Chrysomelidæ.* The first and second of these belong to the *Eupoda.*

In the *Chrysomelidæ* the antennæ are eleven-articulate, and are inserted in front of the eyes; the head is small, and inserted in the prothorax, which is narrower than the elytra. The colors are generally bright, and resemble polished copper, gold, or steel. There are between six and seven hundred species known. They abound in tropical climates, and are common in temperate regions.

In the last section, *Trimera* (*pl.* 81, *figs.* 83–101), of the Coleoptera, the tarsi have three movable and distinct articulations, with the addition of a minute and immovable one. The species are of a small size, the body is short and often hemispherical, and the antennæ are short, with a tri-articulate club. Some feed upon plants, some upon fungi, and others upon the genus *Aphis.* The families are: *Erotylidæ* (*Clavipalpi*, Latr.); 2, *Endomichidæ* (*Fungicola*, Latr.); 3, *Coccinellidæ* (*Aphidiphagi*, Latr.). To these some add the *Pselaphidæ*, the characters of which assimilate them to the *Brachelytra.*

Fam. 1. *Erotylidæ.* These insects are sometimes placed at the end of the preceding section, on account of their tetramerous tarsi. The antennæ have eleven articulations, they end in a compressed club, and are usually inserted in front of the eyes. The edges of the elytra are turned in upon the venter laterally, and they are often marked with impressed points. They live upon plants, and the great majority of the species belong to the American continent. The genera *Triplax*, *Languria*, *Erotylus*, and *Dacne*, have representatives in the United States.

Fam. 2. *Endomychidæ.* These are found in fungi, both in the larva and imago state. Their size is small, the antennæ are eleven-articulate, placed near the eyes, and they are larger than the head and prothorax together. Mulsant terms them *Sulcicolles*, from the longitudinal grooves of the pronotum.

Fam. 3. *Coccinellidæ* (*pl.* 81, *figs.* 93–100). This family includes the little hemispherical insects known as lady bugs. They are of bright colors, and are often marked with spots. When disturbed they emit a yellow fluid from the joints of the feet, which was formerly supposed to be a specific for the toothache. They feed upon Aphides, but the common large yellow American species with the black spots (*Coccinella borealis*), eats cucurbitaceous plants both in its larva and perfect state. These insects pass the

winter in crevices, or under bark, in little colonies. Mulsant has added a considerable number of genera to the family.

ORDER 5. ORTHOPTERA. In this order (*pl.* 80, *figs.* 78–93) the anterior wings (or tegmina) are somewhat coriaceous and veined, with the inner margins overlapping and not meeting in a straight line as in the Coleoptera. The mouth is mandibulate, and much like that of the Coleoptera; the mandibles and maxillæ are well developed, each of the latter being protected by an external jointed galea. The labrum is transverse, the labium four-parted, and with the tongue, labial palpi, and maxillary palpi, well developed. The body is generally long, the head vertical, the antennæ slender, and the thorax much as in the Coleoptera. In some cases the wings are wanting, and sometimes they are so small as to be useless. Some have the anterior wings only, and in one genus the posterior ones are alone present. The feet are well developed, but whilst some forms are very active, the movements of others are remarkably slow. The grasshoppers are perhaps more destructive to growing vegetation than any other family. The *Mantidæ* eat other insects, and the *Blattidæ* or cockroaches destroy both animal and vegetable substances. The *Orthoptera* are generally of a large size, and although in bulk they probably do not surpass the gigantic beetles, in the length of the body and the expanse of their feet and wings the *Phasmidæ* much exceed them, some of them being eight or ten inches long.

The *Orthoptera* are much less numerous in species than the Coleoptera, although in the number of individuals they are at times extremely abundant. There are six families: 1, *Forficulidæ;* 2, *Blattidæ;* 3, *Mantidæ;* 4, *Phasmidæ;* 5, *Gryllidæ;* 6, *Locustidæ;* 7, *Acridiidæ.*

Fam. 1. *Forficulidæ.* This family is considered an order by some authors, under the name of *Dermaptera*, &c. They resemble (*Forficula, pl.* 81, *figs.* 1, 2) the *Brachelytra*, having a slender body, and the elytra short, but they differ in the organs of the mouth, which correspond to the type of the *Orthoptera.* From these they differ in the wings, which have a peculiar structure, and in the peculiar pincer-like organ at the extremity of the abdomen. The wings fold both longitudinally and transversely to bring them under the elytra. They are active, and feed during the pupa state, in which they resemble the typical *Orthoptera.* They run and fly well, live in damp places, and feed upon vegetable food. In Europe they feed upon flowers, and are considered a great pest by gardeners, but the American species seems not to destroy anything valuable, nor is it popularly known by any name. *Forficula* sits over her eggs and carefully watches the young when they appear. The larvæ resemble the adults, but they are without wings, whilst the pupæ show indications of them in an undeveloped state. These insects are trimerous, and the antennæ are long, slender, and composed of many articulations. Some authors admit but one genus in the family.

Fam. 2. *Blattidæ* (*Blatta*, *pl.* 80, *fig.* 93). The family of the cockroaches has the body depressed, the head more or less hidden under the prothorax, the elytra horizontal, with the inner edges passing over each other; the antennæ are long and setaceous, the feet cursorial, the tarsi five-articulate, and the apex of the abdomen with two slender appendages.

The wings of this family are generally better developed in the male than in the female, and the latter has a wider abdomen, with one or two segments less than in the male. The eggs are contained in a capsule resembling a small bean, with one edge serrulate, and this the female carries at her abdomen for some time.

These insects are nocturnal, hiding by day and roaming about in search of food at night. In houses they are most abundant about fireplaces. They infest ships, which have distributed several species over the world, so that it is difficult to tell the original country of some of them. In tropical regions they are extremely troublesome, from their voracity and their numbers.

Fam. 3. *Mantidæ* (*figs.* 90, 91). Body lengthened, prothorax longer than in the remaining thoracic portion, anterior feet raptorial, tarsi five-articulate, antennæ sometimes pectinate, apex of the abdomen with two slender appendages. They are carnivorous, and seize their prey with the anterior feet. The wings are horizontal, and the elytra in the males are larger and narrower than in the females. They remain stationary, waiting for their prey, their prothorax and raptorial feet raised as if in the attitude of supplication, whence they have been called praying insects, and *Mantis religiosa* (*pl.* 80, *fig.* 90) has received its trivial name from this circumstance. They are pugnacious, and when confined together will eat each other. The Chinese make them fight for amusement, and it often happens that one will cut off the head of its antagonist by getting its neck within the grasp of one of its raptorial feet. The eggs are deposited in a single body, and covered with a gummy mass which hardens in the air. The egg mass of *Mantis carolina*, of the Southern United States, will serve as an example. In *Empusa* (*E. gongylodes*, *pl.* 80, *fig.* 91), the antennæ are bipectinate in the male, and setaceous in the female. This genus is remarkable for the leaf-like expansions upon the feet.

Fam. 4. *Phasmidæ* (*pl.* 80, *figs.* 89, 92). Here the elytra are rudimentary, the prothorax shorter than the remaining thoracic portion, the antennæ setaceous, all the feet ambulatory, and the tarsi are usually pentamerous. These insects are phytophagous, and live upon trees; and they present some very curious forms. Some species have wings, whilst others have not the least rudiment of them. In the species which have large wings their anterior margin is thickened, and covers the inner fan-like portion like the outer stiff edge of a fan. Some of these have been named walking-sticks from their resemblance to a stick. *Cyphocrana gigas* (*fig.* 92, from the Moluccas, is ten inches long. The foliaceous expansions upon the feet of the genus *Phyllium* (*P. siccifolium*, *fig.* 89), and the shape and color of the wings, give it the appearance of a leaf, whence its scientific name, that of walking leaf, sometimes given to it in English.

Bacteria femorata, figured in Say's American Entomology, is found from Pennsylvania to Carolina, upon chestnut trees, the leaves of which it eats. The eggs resemble certain seeds; they are mature in autumn, and they are probably laid upon the ground. This is generally a rather rare insect, but Dr. Hiester has discovered that they occur in great numbers in the Monocasy hills in eastern Pennsylvania. He says: "In the latter part

of September, 1846, I observed, at a great distance, the forest on the Monocasy hills to be stripped of its leaves, and to have a peculiar brown appearance. On inquiry, I was told that within a month or six weeks myriads of strange insects had suddenly made their appearance, and were voraciously devouring all the leaves of the forest trees. I had learned, a few days previously, that some insect was committing great ravages on the forest trees at the distance of twenty-four miles in the opposite direction. Individuals from both localities being procured, were found to be the same insect."

Fam. 5. *Gryllidæ* (*pl.* 80, *figs.* 86–88). The family of the crickets were included by Linnæus in his great genus *Gryllus*, and on this account there is some confusion of names. This family was named *Gryllides* by Latreille. and *Achetidæ* by the English. The antennæ are long and filiform, the tarsi generally trimerous, and the abdomen terminating with two long setæ. In the crickets the males produce a monotonous stridulating noise, by rubbing together a peculiar apparatus upon their elytra. Although they have a general resemblance to the grasshoppers, they differ in their habits, being altogether terrestrial, and having the power of burrowing to a greater or less extent. They run well, but do not leap as well as the grasshoppers.

The true crickets generally remain in their burrows during the day, and search for their food at night. In some countries they infest houses, particularly the kitchens, where they are attracted by the warmth. They seem to live both upon vegetable and animal food. The crickets are referred to the genus *Gryllus*, Linn. (*pl.* 80, *figs.* 86, 87), although the English entomologists use the Fabrician name *Acheta*.

Gryllotalpa (*fig.* 88) is a genus in which the anterior feet are short and broad, and adapted for digging, like those of the mole, and like this animal, they burrow beneath the soil, forming a small bridge which marks their course. In Europe it is regarded as a noxious insect, but the American species seems not to be known to horticulturists.

Fam. 6. *Locustidæ.* Variations of this family name are used by the French and Germans, but the English name them *Gryllidæ*, and the Gryllidæ they name *Locustidæ*, apparently for the purpose of making a concession to the vulgar name *locust*, as used in England. In this family the antennæ are setaceous and very long, the wing-covers deflexed, the posterior feet very long and adapted for leaping, the tarsi tetramerous, the abdomen with a pair of small filiform appendages, that of the female having a sharp flattened ovipositor. The males make a loud stridulation by means of their upper wings, near the base of which is a plate of a peculiar construction for this purpose. *Locusta viridissima* (*pl.* 80, *fig.* 85), the *cigale* of the French, is a noisy European species, and the *Platyphyllum concavum* or *Catydid*, is a familiar American example. *Decticus apterus* (*fig.* 83), *D. verrucivorus* (*fig.* 84), are European species; *Poecilocera morbillosa* (*fig.* 82) is from the Cape of Good Hope. These insects are more arboreal in their habits than those of the next family, and from the fine green color of many of them, they are easily overlooked among foliage.

Fam. 7. *Acridiidæ* (*pl.* 80, *figs.* 78–81). This family is named *Acridiens* by the French, *Locustidæ* by the English, and by Burmeister *Acridiodea.*

The body is flattened and robust. The antennæ are short, the posterior feet saltatorial, the tarsi trimerous, the abdomen has two very short appendages, and that of the female is without a prominent ovipositor. These insects produce a stridulation by rubbing their hinder thighs against the wing-covers, and the large common species of the United States (*Œdipoda carolina*), which is found in dry places, such as dusty roads, may be seen hovering a yard or two above the ground over a single spot, the wings then producing a fluttering sound which is not heard in its ordinary flight. This species is brown, with the wings black, margined with yellow.

Acridium cristatum (*fig.* 81), *Œdipoda stridula* (*fig.* 78), *O. cærulescens* (*fig.* 79), *O. migratoria* (*fig.* 80). The last is two inches long, and inhabits central, southern, and eastern Europe, where it occasionally commits great ravages upon the vegetation. Various species are abundantly distributed over various parts of the world.

Order 6. Neuroptera (*pl.* 79, *figs.* 54–76). This is a somewhat irregular mandibulate order, the characters presented by it being varied, and on this account various modifications have been proposed for it. In the *Libellulidæ*, the trophi make an approximation to those of the Orthoptera, to which the order has been united by Erichson, whilst Kirby separates the *Trichoptera* as a distinct order. The antennæ are generally setaceous and short. The four wings have usually reticulate nervures; they are generally of equal size and consistence, and the posterior pair is not generally folded. The pupa is sometimes active and sometimes quiescent. The larvæ are hexapod, mostly predaceous, and they are either terrestrial or aquatic.

Blanchard divides the order into nine tribes, named after the genera *Termes*, *Embia*, *Psocus*, *Perla*, *Ephemera*, *Libellula*, *Myrmeleon*, *Raphidia*, and *Phryganea*, the last belonging to one section, and all the rest to another. Westwood (who considers the *Trichoptera* to be a distinct order) adopts the following arrangement: 1, *Termitidæ;* 2, *Psocidæ;* 3, *Perlidæ;* 4, *Ephemeridæ;* 5, *Libellulidæ;* 6, *Myrmeleonidæ;* 7, *Hemerobiidæ;* 8, *Sialidæ;* 9, *Panorpidæ;* 10, *Raphidiidæ;* 11, *Mantispidæ.*

The *Thripsidæ* (*pl.* 80, *fig.* 51) form a group of small extent, which Burmeister includes in his great order *Gymnognatha.* The species are minute and linear, with four narrow and equal wings, deprived of nervures, strongly fringed with long hairs, and not folded. The mouth is mandibulate, the tarsi dimerous and ending in a vesicle, as in some of the lower *Arachnida.* They are considered hurtful to plants, and it is probable that an American species attacks the human skin, causing an itching like that of *Simulium.* The pupæ are active, and their affinities are with the *Neuroptera.* There are various species in Europe and America. They form Haliday's order *Thysanoptera*, and include a number of genera.

The *Termitidæ* include the genus *Termes* (*pl.* 79, *fig.* 56, *a*, *b*, *c*, *d*) or white ant, which presents many curious features in its economy. The body is white and oblong, the antennæ short and moniliform, the eyes lateral, the stemmata two in number, and the mouth mandibulate, resembling that of the *Orthoptera* in having a galea; and the tarsi are four-articulate. They live together in societies composed of various kinds of individuals.

Besides the male and female, there are some with a large head and mandibles, which are the soldiers, named neuters by Latreille. Pupæ with the wings folded under the integument, are sometimes seen, and the great mass is made up of apterous individuals, which, from occurring of all sizes (some of them being very small), must be larvæ. They are active in all their stages, and the larvæ present the curious fact of being the general workers of the colony. In the American *Termes frontalis*, Hald., the pupæ take their final form in the spring, when they take wing in the morning in great numbers. In a few days the wings drop off, and no winged individuals are seen. This species works galleries in logs and stumps of trees, and is equally abundant in localities suited for ants, or beneath stones, when it forms galleries in the ground, plastering them with a hard mixture of clay. They are never seen out of their burrows except in the winged state. A species in Western Africa, *T. fatalis* (*pl.* 79, *fig.* 56 *c*), builds conical nests ten or twelve feet high, with turrets rising from the surface, and having the entrances beneath the ground. When gravid, the female of this species (*pl.* 79, *fig.* 56 *d*) has the abdomen many thousand times its natural size, being nearly three inches long and three fourths of an inch in diameter, and containing about eighty thousand eggs, which are discharged in twenty four hours. The female, at the time of depositing her eggs, is walled within a hollow prison of clay shaped like a flat apple or turnip, the margin of which is perforated with a row of small holes through which the eggs are said to be ejected. A small species in France destroys furniture, woodwork, and records, its presence being seldom known until it is too late. *T. frontalis* has not been known to appear about houses. Dr. T. S. Savage made extensive observations upon *T. fatalis*, which are detailed in the fourth vol. of the Proceed. Acad. Nat. Sci.

The little apterous louse-like insect, *Troctes pulsatorius*, found among books, belongs to the family of *Psocidæ*. *Perla bicaudata* (*pl.* 79, *fig.* 67) is a representative of the *Perlidæ*.

The *Ephemeridæ* (*pl.* 79, *figs.* 70, 71, 72) are well known by the four wings with nervures in both directions, the anterior pair much the largest, the organs of the mouth but little developed, and the abdomen ending with long setæ. The larvæ live in the water, and the adults are fond of flying in the air, rising vertically above a certain spot, then falling slowly with their wings expanded. These insects were known to Aristotle and Ælian, who named them in allusion to their short life, which in general extends from three hours to a day, although by keeping the sexes apart they will live from one to three weeks. When they leave the pupa state they fly off apparently perfect insects, but the succeeding night they cast off another thin pellicle from all parts, including the wings, and this being found at a distance from the water, and bearing a considerable resemblance to the pupa case as it stands attached by the feet to various objects, conveys the false impression that the pupæ are able to walk a great distance before they are transformed. Pictet of Geneva is the chief authority upon this family.

The *Libellulidæ* are composed of various genera, among which are

Agrion (*pl.* 79, *fig.* 73), *Calepteryx* (*fig.* 74), *Libellula* (*fig.* 75), and *Æschna* (*fig.* 76). They have the body slender, the wings large and reticulated, the head, and particularly the eyes, large, the mouth well developed, and they are of predaceous habits in the larva and imago state. In the latter the feet are slender, adapted for standing rather than for locomotion, and they resemble the swallow in passing most of their time and taking their prey in the air. They are sometimes found in forests, but generally along water courses. The larvæ are aquatic, and the eggs are deposited upon the water by the female, who allows the tip of her abdomen to touch the surface at the time of exclusion.

Among the *Myrmeleonidæ*, the genus *Myrmeleon* (*M. libelluloides*, *pl.* 79, *fig.* 60; *M. formicarius*, *fig.* 61 *a*) is remarkable for the habits of the larva (*fig.* 61 *b*), which forms a conical depression in the ground where the earth is dry and pulverulent (the dust of decayed wood being preferred in the United States). Beneath the bottom of this cavity the larva lies either entirely covered, or with the mandibles exposed. When an ant or other insect wanders across one of these pits, it slides down the sloping side, and the particles which roll to the bottom indicate the presence of an object, upon which the larva, by upward jerks of the head, tosses up a little shower of dust, which, falling on and around the intruder, carries it within reach of its wily enemy. In Virginia this insect is called a *hoodlbug*, and the repetition of this word over its opening in a half singing tone, is said to cause the bug to come from beneath its cover, although it is probable that the breath of the operator is the true cause. *Ascalaphus* (*A. barbarus*, *pl.* 79, *fig.* 59) is remarkable for having the antennæ knobbed, as in some of the butterflies.

In the family *Hemerobiidæ*, the larvæ of *Chrysopa* (*pl.* 79, *figs.* 63, 64) are found upon plants, where they feed upon *Aphides*. *Drepanepteryx phalænoides* is remarkable for its resemblance to some of the small butterflies.

The remarkable American genus, *Corydalis* belongs to the *Sialidæ*. The insects of this genus are of a large size, the mandibles of the male resembling the horns of an ox. The larva is aquatic and predaceous.

In the *Panorpidæ* (*pl.* 79, *fig.* 58), the head is produced into a rostrum. *Panorpa* (*pl.* 79, *fig.* 58), *Bittacus* (*fig.* 57).

In the *Raphidiidæ* (*Raphidia*, *pl.* 79, *fig.* 55), the prothorax is long and the head flattened, presenting a distant resemblance to a snake.

The *Mantispidæ* (*Mantispa*, *pl.* 79, *fig.* 54) have the body somewhat as in *Panorpa*, and the anterior feet are raptorial, resembling those of *Mantis*, with which they were classed by some of the earlier entomologists.

The *Phryganeidæ* (*pl.* 79, *figs.* 65–69) constitute Kirby's order *Trichoptera*, which is adopted by a considerable number of entomologists. The body is soft, the wings are membranous, the posterior pair the larger, and generally folded longitudinally, the anterior generally pilose (whence the name of the order), and the antennæ setaceous. The mouth is mandibulate, but is unfitted for mastication, and the mandibles are obsolete. The pupa is inactive, and the larvæ are aquatic, and generally construct

a case with bits of gravel, sticks, or grass, which they generally drag with them, but some of these cases are affixed permanently to stones. A few species form their cases in the shape of turbinated shells, and these have been described as Mollusca. In most cases their food is vegetable. The adults inhabit damp places near the water; they run with tolerable ease, but do not fly well. *Hydropsyche* (*pl.* 79, *fig.* 65), *Limnophilus* (*fig.* 68), *Phryganea* (*figs.* 66, 69).

Order 7. Hymenoptera (*pl.* 79, *figs.* 1–53). In this order the body is generally of a hard consistence, divided into three distinct portions. The wings are four in number (although sometimes absent) with few nervures; in repose the tips cross each other horizontally; and the posterior pair is the smallest, and attached to the anterior pair during flight by a row of minute hooks. They have a pair of biting mandibles, membranous maxillæ, with palpi, and a labium or tongue. The feet are well developed, and the tarsi are generally pentamerous. The female has an ovipositor or sting. The head and eyes are generally large, and the stemmata rarely absent. The antennæ are variable, but generally slender, and with thirteen articulations in the male, and twelve in the female. The prothorax is much reduced, and the mesothorax well developed for the insertion of the anterior wings. The larvæ are with or without feet, and the pupa is incomplete and incapable of locomotion. The habits of this order excite more interest, and their instincts are more striking than those of any other. The nervures or veins of the wings (at least the anterior pair) are extensively used in classification, each longitudinal or transverse part, and each intermediate area or cell having its peculiar name.

The larvæ of the *Tenthredinidæ* (the only ones which have feet) bear a considerable resemblance to those of the *Lepidoptera*. These feed upon leaves, others feed upon the juices of living plants and animals in which the eggs have been inserted by the mother. Some larvæ feed upon animal food placed near them by the adult, whilst others, like those of ants and bees, are regularly fed by the neuters. The limbs of the pupæ are free, but inclosed in a filament. Adult *Hymenoptera* are mostly found upon flowers and fruits, the mouth being adapted for taking fluids. In general they do not feed much, and in a few cases they are without a mouth.

These insects fly and run well, and some leap with facility. A few simulate death when taken, bringing the abdomen in contact with the thorax at such times. Some defend themselves by biting, and others by a poisonous sting at the extremity of the abdomen, which can be extended or retracted at will. They are of medium size, the largest species (as *Pompilus formusus*, Say) being much smaller than the large *Coleoptera*, *Lepidoptera*, or *Orthoptera*, whilst the small species rival in minuteness those of other orders.

Blanchard divides the *Hymenoptera* into thirteen tribes, with French names, corresponding to the family names: 1, *Apidæ*; 2, *Vespidæ*; 3, *Eumenidæ*; 4, *Crabronidæ*; 5, *Sphegidæ*; 6, *Formicidæ*; 7, *Chrysididæ*; 8, *Chalcididæ*; 9, *Proctotrupidæ*; 10, *Ichneumonidæ*; 11, *Cynipidæ*; 12, *Siricidæ*; 13, *Tenthredinidæ*.

Westwood, who follows Latreille pretty closely, adopts the following arrangement:

SECT. 1. TEREBRANTIA, Latr. Abdomen with a saw or borer for depositing the eggs.

SUB-SECT. 1. SECURIFERA. Abdomen sessile, larvæ feeding upon vegetable matter, and having a well developed mouth. *Fam.* 1, *Tenthredinidæ;* 2, *Uroceridæ.*

SUB-SECT. 2. PUPIVORA. Abdomen pedunculated, having a borer, larva without feet, having mandibulate trophi slightly developed, and generally parasitic in other living insects.

Division 1. *Spiculifera.* Abdomen with an elongate plurivalve oviduct; larvæ generally parasitic in other insects. *Fam.* 3, *Cynipidæ;* 4, *Evaniidæ;* 5, *Ichneumonidæ;* 6, *Chalcididæ;* 7, *Proctotrupidæ.*

Division 2. *Tubulifera*, Latreille. Extremity of the abdomen tubular, retractile, and furnished with a minute sting. Larvæ feeding upon the larvæ of other Hymenoptera, or upon dead insects deposited by the parent of such larvæ for the support of the latter. *Fam.* 8, *Chrysididæ.*

SECT. II. ACULEATA. Abdomen of the females and neuters armed with a poison sting. Antennæ of the male with thirteen, and the female with twelve articulations.

SUB-SECT. 1. PRÆDONES, Latr. Basal articulation of the posterior tarsi cylindrical, not dilated, nor formed for collecting pollen. Larvæ feeding upon other insects stored up, or upon animal or vegetable fluids provided by the neuters. *Fam.* 9, *Crabronidæ;* 10, *Larridæ;* 11, *Bembecidæ;* 12, *Sphecidæ;* 13, *Scoliidæ;* 14, *Mutillidæ;* 15, *Formicidæ;* 16, *Eumenidæ;* 17, *Vespidæ.*

SUB-SECT. 2. MELLIFERA, Latr. Basal articulation of the posterior tarsi dilated and pollinigerous. Larvæ feeding upon honey or pollen paste deposited by the parent or collected by the neuters. *Fam.* 18, *Andrenidæ;* 19, *Apidæ.*

Fam. 1. *Tenthredinidæ.* In this family the body is short and subcylindrical, the thorax robust, and bearing large wings with more numerous areas than in the other families. The antennæ are short, the mandibles strong, and the maxillary palpi are six-articulate. The abdomen of the female is provided with a pair of saws, which are regularly toothed, and present various modifications, probably adapted to the nature of the material to be sawed, as we know that the saws used in mechanical operations must be varied according as the wood is wet or dry, hard or soft. The two saws are applied together and worked with an alternate motion, one being drawn back when the other goes forward, sawing a groove in tender bark, or in leaves, in the latter case either beneath the ribs, or in the edge. In this groove the egg is inserted. The young live either in galls which are the result of the wounds, or, coming forth, they feed upon leaves. Some species do not saw grooves for the eggs, but affix them to leaves and branches. The larvæ in this family have a close resemblance to those of the Lepidoptera, having, like them, six thoracic feet; but they have generally from twelve to sixteen abdominal or false feet, whilst those of the former have not more

than ten. They are destructive to various cultivated vegetables, and some feed upon the leaves of the pine.

Lophyrus (*pl.* 79, *fig.* 43) is remarkable for having the antennæ multi-articulate, those of the male being bi-pectinated, and those of the female serrate. The larva of *L. pini* is sometimes very destructive to the pines in Europe. *Nematus* (*fig.* 44) has the antennæ slender and nine-articulate in both sexes. The larvæ have six true and fourteen false feet. They live upon leaves and change in the ground, where they form a cocoon. *Cimbex* (*figs.* 45, 47) has a heavy body, and the antennæ with five articulations, in addition to a terminal club. The species are of rather large size, and some of them are finely colored. *C. americana* is described by Dr. T. W. Harris in his report on injurious insects.

Fam. 2. *Uroceridæ.* The genus *Urocerus*, Geoff., 1764 (*Sirex*, Linn., 1767), of which the European *U. gigas* (*pl.* 79, *fig.* 42) is a good example, is the type of this family. The body is lengthened, cylindric, and the abdomen united by its entire base, and furnished in the female with a borer for inserting the egg in living trees, chiefly of the resinous kind, to which the larvæ are at times very destructive.

Fam. 3. *Cynipidæ* (*figs.* 48–53). This is a family of small insects, the larvæ of which are generally parasitic in plants, where they cause the excrescences named galls. The antennæ are straight, and have from thirteen to sixteen slender articulations. The female has a slender ovipositor, which is internal and spiral in a state of repose. The irritation of depositing an egg in the plant causes an excrescence, and the continued feeding of the larva upon its internal part continues to keep up the abnormal action until a gall is formed, of large size, compared with that of the little insect which finally leaves it.

Fam. 4. *Evaniidæ.* In this family the posterior feet are the stoutest, and the abdomen is affixed to the metanotum. *Evania* has a very small abdomen, and is parasitic in the *Blattæ*. Dr. Reinhardt found a species upon the U. S. ship Constitution, in various parts of the world (including Cochin China and Rio), where it doubtless accompanied the *Blattæ* which infest shipping. In the American genus *Pelecinus*, the abdomen of the female is remarkably long and slender.

Fam. 5. *Ichneumonidæ* (*pl.* 79, *figs.* 32, 33, 37–39, 45). The body of these insects is narrow, the antennæ rather long, of numerous articulations, and vibratile. The feet are long, and adapted for running, and the ovipositor straight. These insects are abundant in species and individuals, the size varies considerably, but the greater part are small, and some are minute. The larvæ are the chief enemies of the Lepidoptera, under the skin of the larvæ of which the eggs are deposited by means of the ovipositor of the female *Ichneumon*. The young feeds upon the internal parts of the caterpillar, avoiding the vital organs, and by the time the young *Ichneumon* has acquired its full growth, the caterpillar is ready to die. Sometimes the caterpillar changes into the pupa state, from which the parasite makes its appearance. A caterpillar may contain a single larva of an *Ichneumon* of a large size, or fifty or more small ones. They are not confined to Lepi-

doptera, but attack Coleoptera, Diptera, and probably members of all the orders. Among the Hemiptera, the Aphides are extensively destroyed by minute *Ichneumons*. In some cases a parasitic Hymenopter is itself attacked by a smaller member of the same order. The eggs of insects and spiders are similarly attacked, and spiders also. These insects are very active, flying and running about in a restless manner, and vibrating the antennæ as if excited. In their perfect state they are found upon flowers. They are generally black or red colored, varied with white or red, the middle of the antennæ being often white.

Fam. 6. *Chalcididæ* (*pl.* 79, *figs.* 34, 35). This is an extensive family mostly of minute parasitic insects, many of which have bright or metallic colors. In some forms the hinder femora are very thick, in some the antennæ of the male are branched, and in *Leucospis* (*fig.* 23), the ovipositor of the female, when unemployed, is turned up along the dorsum.

Fam. 7. *Proctotrupidæ.* This family contains minute species, with habits like the two preceding families. Some of them are so small, that a number of them may be parasitic in a single egg of a butterfly.

Fam. 8. *Chrysididæ* (*Chrysis*, *pl.* 79, *figs.* 24, 26). This is a family of small, oblong-bodied, brilliant, metallic-colored insects, which have the power of rolling themselves into a ball, or at least of applying the venter to the thorax beneath. The abdomen is attached by a short peduncle, its extremity has a tubular exsertile ovipositor, which is moved like the joints of a telescope, and the termination is a sharp point. They are very active, and may often be seen during hot weather upon fences or dry sand, vibrating their antennæ and moving about. Westwood thinks the egg is deposited upon the food intended for the larvæ of other species, and of which it deprives the proper owner.

Fam. 9. *Crabronidæ* (*Crabro*, *fig.* 29). In this, the first family of the Aculeata, the head is large and quadrate, the antennæ short, the feet slender, the anterior tibia with a pectinated spur, and the abdomen of the female provided with a sting. The general color is some dark tint varied with yellow spots. The adults frequent flowers, but feed their young with insects. They gnaw holes in wood, in which they lay their eggs, and a stock of provisions consisting of other larvæ or adult insects; and we have on two occasions found dead branches of trees (bored probably by members of this family) filled with Diptera, a single species of the latter being taken in each case. The insects taken for the food of the young are not killed entirely, but rendered torpid, so that they may not decay before they are wanted. When the store is complete the aperture is closed.

Fam. 10. *Larridæ.* This is a small family allied to the preceding; the labrum is hidden, and the mandibles have a notch near the external base.

Fam. 11. *Bembecidæ.* This is the smallest family in the order. The mandibles are pointed, have an internal tooth, and the labrum is exserted. It contains the genera *Bembex*, *Monedula*, and *Stizus*. These insects lay up a store of insects in the ground for their young. Some of the species of *Stizus* are considerably larger than hornets; of black or dark colors,

generally ornamented with yellow spots. The common species of the United States, *S. speciosus*, Drury, kills and carries off *Cicada* (*pl.* 80, *fig.* 75) *pruinosa*, a large locust much larger than itself, the locust, during the attack (if a male), making a great noise with its sounding organs.

Fam. 12. *Sphegidæ* (*pl.* 79, *figs.* 27, 28, 30, 31). Here the body is elongated, the abdomen is attached by a long slender peduncle, and is armed with a sting. The mandibles are slender and curved, and the feet long, and generally fossorial. These insects are very active and restless, running about dry places, or along water courses, keeping their wings in a state of vibration. They suck the fluids of flowers, but the larvæ are provided with animal food by the adult. *Ammophila sabulosa* (*fig.* 31), which seems to inhabit the United States as well as Europe, digs a hole in sandy places, and stores it with spiders for the young. *Pelopæus* (*fig.* 30). *P. flavipes*, the mud-wasp of the United States, may be seen forming small balls of mud along water courses, especially where cattle are watered, as there is no grass present, and the earth and water meet gradually and nearly on the same level, so that the ground is generally made wet a few inches from the margin by the capillary attraction and the small ripples. When the ball of mud (which is about an eighth of an inch in size) is ready, the wasp takes it to its nest, which may be in a garret, or under the eaves of a house. Here the nest is formed, a cell at a time, each after the first one being attached parallel with the preceding ones, and generally (perhaps always) in a horizontal direction, or nearly so. Sometimes a space of three inches in length will be covered by allowing successive cells to be attached side by side, but in other cases not more than three will be attached (perhaps to the lower side of a rafter), and the succeeding ones will be attached or suspended to these until the mass assumes the form of an elongated sub-quadrate prism attached by one end. In rare cases the nest is built upon the upper surface of a rafter. The cells are filled with spiders for the larvæ, and then closed with mud. The pupa is inclosed in a translucent yellow cocoon resembling very thin oiled paper. Westwood (Introduction, ii. 207), judging from observations made by W. W. Saunders, thinks that these constructions are made by *Eumenes;* but if the latter is concerned, *it* is probably the parasite, or the *Pelopæus* may take a cell already formed in preference to building one. The United States species of *Eumenes* are not known to enter houses, where *Pelopæus* is constantly seen, although they may both be found in the same vicinity out of doors.

Some authors separate *Pompilus* (*figs.* 27, 28), and some allied genera, to form a separate family.

Fam. 13. *Scoliidæ.* Some authors divide this family into two portions (considered sub-families by Westwood) of which *Scolia* and *Sapyga* are the types. In the former the antennæ are short and curled, and the feet thick and spinose; whilst in the latter the antennæ are straight and long, and the feet thin. The first contains some large species. The European *S. flavifrons* deposits its eggs in cavities in the earth occupied by the larva of the large Coleopter, *Oryctes nasicornis* (*pl.* 81, *fig.* 145), upon which it lives.

Fam 14. *Mutillidæ.* This family approaches the *Formicidæ* (ants) in general appearance, but the species are solitary, and provided with a long curved sting which can be used very effectually, on account of the flexibility of the abdomen. There are but two kinds of individuals, male and female, the latter being apterous. The species inhabit hot and sandy localities, and they are often covered with short hair, sometimes vividly colored with red, yellow, and black. *Mutilla* (*pl.* 79, *fig.* 1), *Apterogyna fig.* 2).

Fam. 15. *Formicidæ* (*pl.* 79, *figs.* 3–9). This is the family of the ants, in which the head is triangular, the antennæ filiform, and elbowed at the end of the basal articulation, the mandibles robust, the abdomen oval and attached by a narrow pedicle, and the feet slender and cursorial. These insects live in society in burrows of their own construction, which are found in the earth, or in dead trunks of trees. Some form a rough hill out of clay mixed with bits of vegetable material. *Formica merdicola*, of Brazil, builds a nest of dry horse excrement, upon the stems of reeds and trunks of trees. A somewhat similar nest (figured in Kirby's Bridgewater Treatise) is constructed upon the branches of trees by *Myrmica kirbii.*

The Brazilian *Formica elata* of Dr. Lund makes a nest upon the trunks of trees out of clay and leaves. A minute species of the United States, which seems to be *Myrmica domestica*, is found in small colonies under stones, but it occasionally takes up its residence in old galls upon oak shrubs, entering by the aperture made by the retiring *Cynips*, and adapting the interior to its purpose. The same species swarms in some houses, both in America and England.

A few individuals like workers, but with a very large head, are sometimes found. Among the *driver ants* of Western Africa, according to the observation of Dr. T. S. Savage, there are three or four kinds: *neuters*, *soldiers*, *workers*, and *carriers.*

Besides the ordinary males and females, which are not numerous, the societies of ants are made up chiefly of workers, sometimes named neuters, which are abortive females without wings, of a smaller size and more industrious habits than the others. These have all the work of the establishment to perform, whether in building, collecting food, or taking care of the eggs and young. The difference between a worker and a female is probably due to a peculiar mode of feeding, as with the bees, where the larva, if a worker, is transformed into a queen when accident deprives the hive of the latter. The male and female are winged, but the wings are dropped after a certain time, and the latter is larger than the former.

In cold climates the male and female ants die in winter, and the neuters remain torpid, so that they do not require a stock of food. But under other circumstances a store of food is collected. Thus an East Indian species collects a great quantity of grass-seed, which is brought to the surface to dry after the heavy rains of that country. Ants are fond of the liquid matter exuded by the *Aphides*, and they frequent the trees where they are found, for the purpose of getting it; and by annoying the *Aphis* they can cause it to furnish a globule. Certain species of *Membracis* are treated

similarly before they have attained their perfect state. Sometimes Aphides are kept prisoners by the ants; and we have observed a number of one of the species which infests the roots of grass, in their natural position upon the roots beneath a stone occupied as an ants' nest.

In the genus *Polyergus* the mouth is not adapted for building; and as the economy of the nest must be carried on, they make predatory excursions to the nests of two other species of ant, and take their young workers in the pupa state. These assume their perfect state in the domicile of their captors, and become the slaves of their community, all the labor of building, collecting food, and taking care of the young, falling to them.

St. Fargeau thinks that *Polyergus* exhibits the "perfection of instinct," being capable of laboring, but preferring idleness; but Huber asserts that they have no talent except that of war, and on placing some of them in a glass with their pupæ, they began to die from want, until an individual of *Formica fusca* was introduced, which preserved the remainder. In Europe, a true working *Formica* makes slaves of two other species, although it assists in the work; and in the United States the large yellow ant makes slaves of the black ones, both being true *Formicæ*, and both working. (See Westwood's Introduction, ii. 232.)

The habits of the *driver ants* of West Africa (which are the neuters of the genus *Dorylus*) are carefully detailed in the Proceed. Acad. Nat. Sci., iv. 196. They are very fierce, have no permanent abode, and live temporarily in crevices. They travel at night or in cloudy weather, and if overtaken by the sun they protect themselves by an arch of earth made adhesive by a fluid from the mouth. Without this they would die, the direct rays of the sun killing them in two minutes. It being necessary to protect the young in migrating, an arch is made of the bodies of the soldiers, which interlock their jaws and feet for the purpose of forming it. They move in great armies, and when they enter a house, rats, lizards, &c., and even man, take their departure. They destroy large serpents, and domestic animals confined in stables. Dogs and asses are afraid to leap over their line when on a march.

Fam. 16. *Eumenidæ.* In this family the sexes appear in their ordinary condition, and the species do not live in society. They resemble wasps, and construct mud cells in which the egg is placed with insects, larvæ, or spiders, the aperture being then closed.

Fam. 17. *Vespidæ* (*pl.* 79, *figs.* 20–22). This includes the wasps, which in some points of their economy approach the bees, and like these, there are males, females, and workers. Many of the species are black or dark colored, varied with white and yellow. They are widely distributed, especially in warm regions, and they live in societies during the summer, building nests of hexagonal cells, made of a paper-like material, and often inclosed in a globular covering of the same material, as in the case of the hornets. They feed upon insects, fruit, honey, and other materials; and the large American hornet, *Vespa maculata*, often comes about houses to catch flies. The larvæ are fed by the adults, and when they are ready to assume the pupa state they inclose themselves by spinning a convex cap over the

mouth of their cell. The fecundated females survive the winter, and each commences a new colony, building cells, depositing eggs, and feeding the young, until these are old enough to take part in the labors of the establishment, which is about a month from the time the eggs are laid. Two or three broods are raised successively from the same set of cells during a season. The nests of *Vespa* may be seen upon trees (where they are sometimes from twelve to eighteen inches in diameter), or under the projecting parts of houses. The small American species known as "yellow jackets," build under ground; and the "paper-wasp," *Polistes fuscata*, attaches its comb (with the mouth of the cells downwards) to the branch of a tree, to the shelving parts of houses, or beneath a stone which has a cavity under it. *Polistes* (*fig.* 20), *Vespa vulgaris* (*fig.* 21), *Vespa crabro* (*fig.* 22). A few species of *Polistes* collect stores of honey.

Fam. 18. *Andrenidæ.* In this family, which is allied to the bees in form, there are only males and females. They are solitary; the female digs a hole in the ground where she deposits her eggs and a stock of paste made of pollen and honey, the hole being afterwards closed.

Fam. 19. *Apidæ* (*pl.* 79, *figs.* 10–18). The family of the bees contains various groups differing in their character and habits. *Xylocopa* (*X. violacea*, *fig.* 14) bores passages in wood in which the young are placed with a quantity of pollen paste. In the United States, *X. victima* bores in the lower surface or edge of white pine structures, particularly about houses. The species of *Bombus* (*figs.* 10, 13) known as *bumble bees*, make their nests under ground, in fields and pastures. The females (which are not restricted in number) assist the neuters in working. The colony does not remain together in the winter. *Megachile* (*fig.* 12 *a*, male; *b*, female). *Nomada* (*fig.* 15) is distinguished by its bright colors, and *Eucera* (*fig.* 16) by its long antennæ.

Apis mellifica (*fig.* 18 *a*, female; *b*, male; *c*, worker) is the common hive bee. The male (or drone) is somewhat larger than the workers, it is without a sting, the eyes meet upon the top of the head, the posterior tarsi have the basal articulation lengthened, and not square, as in the neuters, the thorax and abdomen are less distinctly separated, and the wings are longer than in the female and neuter. There may be from six or seven hundred to two thousand males in a hive, but this number is not in proportion to the other inmates. The females have the wings abbreviated, and the abdomen lengthened and provided with a curved sting, that of the workers being straight. The antennæ and feet are paler than in the workers.

Bees collect honey, pollen, and propolis, the young being fed with a mixture of the two former, whilst the latter (which is a mixture of one part wax to four of resin) is used to stop crevices and make repairs. The wax is a secretion between the segments of the lower side of the abdomen of the workers, where it appears in the form of small scales.

When accident or death deprives a hive of its queen, great confusion follows, but in a few hours several cells containing worker larvæ two or three days old are enlarged, and these young are supplied with the peculiar

food given to queen larvæ. Several new queens finally appear, and a conflict ensues, till one only survives. If a strange queen is introduced soon after the original one has been removed, it is surrounded and starved, but never stung; though if the interval of eighteen hours has elapsed, the stranger will be at first surrounded, but afterwards allowed to go. If, however, the hive has been twenty-four hours without a queen, the new comer takes her place as queen. When two queens come together they fight until one of them is killed.

Most of the eggs laid by the female bee are those of workers, until she is about eleven months old, when two or three thousand male eggs are laid at the rate of forty or fifty a day, and this generally happens in March and April, a smaller amount of male eggs being laid in autumn. Whilst laying the male eggs, the queen also lays the few which are to produce females, and these are deposited in "royal cells" constructed for the purpose, of a large size, and not placed in regular series like the others. These eggs are not laid faster than one a day, and seldom to the number of twenty; and they are placed at once in the royal cells by the queen, who inserts her abdomen for the purpose.

When the young females approach their adult state, the queen becomes uneasy, she communicates her uneasiness to the workers, and in their confusion they all go forth with the old queen, thus forming a new swarm; but as this occurs in fine weather when many of the bees are abroad, these, upon their return, take care of the hive, and others soon leave the pupa state.

The female eggs (not being laid simultaneously) come to maturity at different times; and when the young female leaves its pupa state, it begins to gnaw an aperture for its egress, but the workers prevent this for two days by stopping the place with wax. When she finally emerges, she endeavors to go to the other royal cells to destroy them and their inmates, but she is prevented by the workers, and another scene of confusion ensues which, in a full hive, ends in a second swarming. This reduces the workers so much, that when another female emerges she cannot be prevented from destroying the royal cells and their contents, so that she becomes queen of the hive, although she may have to fight with others which emerge about the same time. Small hives do not send off swarms, and in this case royal cells are not made nor female eggs laid. After swarming the males are killed, and being without a sting, they readily succumb under the stings of the workers.

Various species of the bee are kept for the honey. That of Italy is different from the *Apis mellifica* of Northern Europe and the United States.

ORDER 8. LEPIDOPTERA. In this order the metamorphosis is complete, the antennæ multi-articulate, the labrum and mandibles rudimentary, the maxillæ forming a spiral sucker, the labial palpi are large, the wings broad with branching nervures, and having both surfaces covered with minute scales.

These insects are known under the general name of *butterflies;* some small species which destroy cloth in their larva state (or the larvæ them-

selves) are called *moths*, and the species of Sphinx are named *humming-birds.* The body is generally clothed with a hairy covering, the eyes are usually large, and the stemmata, when present, are usually hidden by the hair. The antennæ present several types of form, but in their details they offer some important variations from the simple types. The scales of the wings contribute much to the variety and splendor of the tints observable in these insects, which probably surpass all the other orders in their coloring. In a few the disks of the wings are without scales, leaving them transparent. The distribution of the nervures in the wings varies, and is now employed in classification. The wings are reduced in size, or wanting, in some females. In some genera they are carried vertically over the back, in some they are horizontal, and in others deflexed. The feet are pentamerous, generally hairy, and in most cases of equal length; but in some the anterior pair are so much reduced in size as to be of no use in walking.

The liquids of flowers furnish the Lepidoptera with food, but in some cases they require none in the adult state.

In the larva state they are known as voracious eaters, under the name of caterpillars. These have a mandibulate mouth, composed of a pair of corneous mandibles, a pair of maxillæ each with a small palpus, and a labium with two palpi. They have six thoracic feet corresponding to those of the imago, and a number of abdominal or false feet, varying from four to ten. These are used chiefly for holding, and the former for walking. They generally move forwards, but those of the *Tortricidæ* can move rapidly backwards, and some, by bending and straightening the body suddenly, can leap. Some caterpillars are smooth, some covered with hair, which may be harmless, or with the quality of nettles, and it may be long or short, dense or sparse, bristly or woolly; and some of them have horn-like projections. Some are ornamented with various bright colors; some which feed upon leaves are green, some found among lichens have their color, and others which feed upon branches resemble a projecting stick, as if to prevent their numerous enemies from readily recognising them. In a few cases the caterpillar forms a case for itself, with which it moves about, and into which it withdraws when danger threatens. In growing, caterpillars moult frequently, and undergo various changes in color. They usually rest by day and feed by night. Some are solitary and wandering, and some live in society, either in large webs, or congregated upon a single spot. A few live upon skins, hair, and wool, but the great majority of caterpillars feed upon vegetables, including leaves, roots, seeds, and grain. The most acrid and acid leaves are eaten by some species; some devour almost every kind of plant, and some plants feed various species. The pupa has the feet, &c., hidden, and is motionless, except that the articulations of the abdomen are capable of moving. Some of these are inclosed in a silken cocoon, some in a cocoon formed chiefly of the hair of the caterpillar, whilst others suspend themselves without any exterior covering.

These insects are divided according to their habits into three sections by Latreille: The first (*Diurna*) include those which fly by day, and with very few exceptions they have the antennæ knobbed; the second (*Crepuscularia*),

those which fly by twilight, and have the antennæ gradually thickened; and the third (*Nocturna*), the night-fliers, in which the antennæ are usually filiform. These sections correspond respectively to the extensive Linnæan genera, *Papilio*, *Sphinx*, and *Phalæna*. But the terms of these sections are not exact, because some of the Crepuscularia and Nocturna are day-fliers, and on this account Boisduval applied the name *Rhopalocera* (meaning club-horned) to the Diurna, and *Heterocera* to the others, on account of their antennæ being variously formed. Blanchard names the latter *Chalinoptera*, because they (generally) have a kind of bridle to unite the posterior to the anterior wings, and the former (the Diurna), *Achalinoptera*, because they want this contrivance. The Achalinoptera (or Diurna) he separates into five tribes: *Papilioniens*, *Nymphaliens*, *Eryciniens*, *Hesperiens*, and *Cydimoniens*.

The Chalinoptera he divides into nine tribes; *Castniens*, *Sesiens*, *Zygæniens*, *Sphingiens*, *Bombyciens*, *Noctueliens*, *Uraniens*, *Phaleniens*, and *Pyraliens*.

Westwood divides the Rhopalocera into the families: 1, *Papilionidæ;* 2, *Heliconiidæ;* 3, *Nymphalidæ;* 4, *Erycinidæ;* 5, *Lycænidæ;* 6, *Hesperidæ;* and the Heterocera into: 1, *Sphingidæ;* 2, *Uraniidæ;* 3, *Anthroceridæ* (or *Zygænidæ*); 4, *Trachiliidæ* (or *Sesiades*, Latr.); 5, *Hepialidæ;* 6, *Bombycidæ;* 7, *Arctiidæ;* 8, *Lithosidæ;* 9, *Noctuidæ;* 10, *Geometridæ;* 11, *Pyralidæ;* 12, *Tortricidæ;* 13, *Yponomeutidæ;* 14, *Tineidæ;* 15, *Alucitidæ*.

In the Nomenclator Zoologicus of Agassiz the following families are admitted, but a uniform termination is not given: *Papilionides*, *Nyctalideæ*, *Sphingides*, *Sesiæ*, *Zygænides*, *Chelonarii*, *Bombyces*, *Noctuæ*, *Geometræ*, *Pyralides*, *Tortrices*, *Tineæ*, *Pterophorii*.

Fam. 1. *Pterophoridæ*. This family includes several genera of small insects remarkable for having all the wings deeply split into narrow pieces which are fringed and resemble feathers, whence one of the genera has been named *Pterophorus* (*P. pentadactylus*, *pl.* 79, *fig.* 77). The rays of the wings can be folded over each other.

Fam. 2. *Tineidæ* (*pl.* 79, *figs.* 81–87). This is an extensive family of small narrow-winged butterflies, with the rostrum generally rudimentary, and the antennæ ordinarily raised over the head. These insects are among the smallest of the Lepidoptera, and although their colors are generally sombre, many of them are beautiful objects. In their larva state various species, as *Tinea pellionella* (*fig.* 84), are destructive to clothing, feathers, hair, and similar materials, which are used as food, and to construct a kind of cocoon which the larva carries with it. The larvæ of other species (as *Tinea granella*, *fig.* 81) feed upon stored grain.

Gallerea cereana (*fig.* 83) lives in beehives, where it destroys the honey and causes the death of the bees. The larva seems to feed upon the wax. Some authors separate *Hyponomeuta* and a few other genera in which the wings inclose the sides, and the posterior ones are the largest, and folded. *Hyponomeuta* (*figs.* 86, 87), *Plutella* (*fig.* 82), *Lemmatophila* (*fig.* 85).

Fam. 3. *Tortricidæ* (*pl.* 79, *figs.* 78, 79, 90, 91, 92). In this family the wings are enlarged near the shoulder, a little deflexed, and when closed,

forming a triangle. The larvæ are naked, and have sixteen feet. They feed chiefly upon leaves, the edges of which they roll up into a tube and fasten with silk. In this they readily move backwards and forwards.

The larva of *Carpocapsa pomonella* (*fig.* 79), known as the apple worm, lives in apples, causing them to fall prematurely. *Tortrix viridana* (*fig.* 91) is very destructive to the foliage of oak forests. The larvæ of *Coccyx resinosa* (*fig.* 78), and two other species, eat the buds and leaves of pine trees in Germany; and being very abundant, they cause great damage. *Sciaphila literata* (*fig.* 90), *Halias prasinana* (*fig.* 92).

Fam. 4. *Pyralidæ* (*pl.* 79, *figs.* 80, 88, 89). These insects are of a small size; in repose the wings generally form a triangle, and the feet are long, particularly the anterior ones, which are often fasciculate. *Hypena* (*H. rostralis*, *fig.* 88) is found in grass; and the larva, which has fourteen feet, rolls the edges of a leaf in which it undergoes its transformations. *Hercyna* (*H. palliotalis*, *fig.* 80) has a stout body, the wings short and dark satin colored, and the species inhabit mountainous regions in Europe. The larva of *Botys* (*B. verticalis*, *fig.* 89) has sixteen feet, and has the habits of that of Hypena. The adult inhabits moist and shady places, and is generally found upon the lower side of leaves.

Fam. 5. *Geometridæ* (*pl.* 79, *figs.* 93–101). The name of this family is derived from the locomotion of the larvæ, which, having often but four false feet, and these placed at the posterior extremity, move by stretching the body, holding by their thoracic feet, and then bringing up the posterior portion, forming a loop with the central part; and when the posterior false feet have taken a new hold, the anterior part is again stretched forward. Some of the larvæ have twelve or fourteen feet; they feed upon the leaves of various plants; and like the caterpillars of some other families, they can suspend themselves by a thread. The body of the imago is slender, and the wings are sometimes irregularly shaped, and somewhat varied in their coloring. They are nocturnal, and common in forests. When disturbed during the day, they fly a short distance, and hide in the herbage.

The species figured in *pl.* 79, are *Abraxis grossulariata* (*fig.* 94), *Acidalia brumata* (*fig.* 93), *A. viridata* (*fig.* 97), *Boarmia hortaria* (*fig.* 95), *Geometra papilionaria* (*fig.* 96), *Crocallis elinguaria* (*fig.* 98), *Fidonia wavaria* (*fig.* 99), *Ennomos syringaria* (*fig.* 100), *E. alniaria* (*fig.* 101), *Ourapteryx sambucaria* (*fig.* 102).

Fam. 6. *Noctuidæ* (*pl.* 79, *figs.* 103–123, 129, 136). In this family the body is robust, the tergum often with a bunch of hair, the antennæ simple, but sometimes pectinate or crenulate in the males, wings often declivent in repose, and marked in many species with undulating lines. The larvæ are generally sixteen-footed, and live upon trees between leaves which they join with silk. The pupa occupies the same places, or a cocoon upon or beneath the earth. The distinctions between many of the genera are slight and difficult to identify. The mouth is well developed, and the maxillæ long. The species figured are *Heliothis delphinii* (*fig.* 103), *Mamestra pisi* (*fig.* 104), *M. oleracea* (*fig.* 105), *M. brassicæ* (*fig.* 107), *Trachea atriplicis* (*fig.* 108), *Tr. præcox* (*fig.* 111), *Polia chi* (*fig.* 112), *Acronycta rumicis* (*fig.* 106), *A. psi* (*fig.*

113), *Miselia oxycanthæ* (*fig.* 109), *Plusia triplasia* (*fig.* 110), *P. gamma* (*fig.* 118), *Xilina exoleta* (*fig.* 114), *Cucullia umbratica* (*fig.* 115), *C. verbasci* (*fig.* 116), *Phlogophora meticulosa* (*fig.* 117), *Triphæna pronuba* (*fig.* 119), *Catocala fraxini* (*fig.* 120), *C. pacta* (*fig.* 121), *C. sponsa* (*fig.* 122), *C. paranympha* (*fig.* 123), *Scoliopteryx libatrix* (*fig.* 129), one of the few species found in America as well as in Europe; *Episema cæruleocephala* (*fig.* 136).

Fam. 7. *Bombycidæ* (*pl.* 79, *figs.* 130–135, 137–151; *pl.* 80, *figs.* 4–7). This is the family of the silkworms, which contains some of the largest and handsomest species of nocturnal butterflies. The mouth is in most cases rudimentary, the wings in repose are either horizontal or deflexed, and the antennæ bi-pectinate in the males. The larvæ have sixteen feet; they feed upon leaves, and spin a silken cocoon out of a single thread, with the aid of a gummy matter, which soon hardens. Several species are reared for the silk, and this valuable material might be furnished in greater quantity, were it not that in some cases warm water will not dissolve the gum of the cocoon as it does in *Bombyx mori* (*pl.* 79, *fig.* 149), and in others the silk is so intermixed with leaves, and wrapped about branches, that there is a difficulty in unwinding it. Some of the larvæ are gregarious, living together in large numbers, spinning webs upon trees, and often destroying vegetation. Some of the large members of this family, as the Chinese *Hyalophora atlas*, have a bare space in the wings which is as transparent as mica. In others this is replaced by colored spots.

Cossus ligniperda (*pl.* 79, *fig.* 135), is three inches or more in the expanse of the wings; its color is whitish varied with brown, and streaked with black. The larva burrows in the living wood of willows, poplars, and ash, feeding upon the chips which it separates with its powerful jaws. It grows three years in the larva state, when it becomes a pupa in one of its galleries, in a cocoon made of silk mixed with fragments of wood.

Clisiocampa castrensis (*pl.* 79, *fig.* 146), *C. neustria* (*fig.* 147), *Eriogaster lanestris* (*fig.* 150), *Pæcilocampa populi* (*fig.* 140), *Lasiocampa rubi* (*fig.* 151), *Notodonta camelina* (*fig.* 130), *N. ziczac* (*fig.* 134), *Cerura vinula* (*fig.* 148), *Orgya antiqua* (*fig.* 133), *O. fascilena* (*fig.* 137), *Liparis chrysorhœa* (*fig.* 141), *L. dispar* (*fig.* 142), *Pygæra bucephala* (*fig.* 128), *Clostera curtula* (*fig.* 138), *Demas coryli* (*fig.* 139).

Lasiocampa quercus (*pl.* 80, *fig.* 1), *Dendrolimus pini* (*fig.* 2), *Odonestis potatoria* (*fig.* 3), *Gastropacha quercifolia* (*fig.* 5), *Aglia tau* (*fig.* 6), *Nagelflecknusstrauchrothbuchenspinner*.

Fam. 8. *Arctiidæ*. This family is named *Chelonides* by Boisduval, and is recognised by the spotted abdomen, and the bright colors of the wings, particularly the inferior ones. Westwood places *Notodonta* and its allies in this family, whilst Boisduval and Stephens place them in a distinct one. The genus *Arctia*, as given here, admits of a division into various subgenera.

Callimorpha jacobææ (*pl.* 79, *fig.* 124), *Arctia fuliginosa* (*fig.* 125), *A. matronula* (*fig.* 126), *A. dominula* (*fig.* 127), *A. purpurea* (*fig.* 131), *A. lubricipeda* (*fig.* 132), *A. hera* (*fig.* 143), *A. caja* (*fig.* 144).

Fam. 9. *Zygænidæ.* This family is sometimes namea *Anthroceridæ*, but as the genus *Zygæna*, Fabr., 1775, has priority of *Anthrocera*, Scopoli, 1777, it must be preferred. The generic name *Zygæna*, applied to a fish by Cuvier, in 1817, can have no influence against the former name. The members of this family resemble *Sesia* and *Ægeria* in being diurnal fliers, and in some the antennæ are terminated in a club. The wings are narrow, and have numerous nervures, and the feet and maxillæ are long. They are of small size and bright colors, and their movements are sluggish.

Zygæna filipendulæ (*pl.* 80, *fig.* 8) has the upper wings black, spotted with crimson, and the lower ones of the latter color margined with blue. Its expanse is an inch or more. Europe.

Fam. 10. *Trochiliidæ.* The insects of this family are day-fliers, and bear some resemblance to *Sesia* (*pl.* 80, *fig.* 9), but the body is more slender, and the movements are more sluggish. Some of them are gaudily colored, and have naked wings, which, with their form, give them a general resemblance to Hymenoptera and Diptera, whence have been derived the trivial names of *Sphecia apiformis*, *Trochilium vespiforme*, *sphegiforme*, *culiciforme*, and many similar ones. The larvæ bore under the bark and in the wood of trees, which they sometimes damage, as in the case of the American *Egeria exetiosa*, which destroys peach trees by attacking them below the surface of the ground. In this species the wings are transparent in the male alone. A closely allied, but smaller species (*Trochilium cerasi*), causes rough excrescences upon the branches of cherry trees in the United States.

Fam. 11. *Sphingidæ*, (*pl.* 80, *figs.* 10–21). These have a robust hairy body, the abdomen conical, the antennæ thickened towards the end, and prismatic; the rostrum is in some cases longer than the body, and the wings are narrow and strong, with the posterior pair small. Their flight is rapid and well sustained, resembling that of birds: and as the common words *bird* and *fish* are applied in a general and not in a technical sense, the common name of these nocturnal butterflies is *humming-birds.* The species fly from flower to flower, in the dusk of evening, balancing themselves on the wing in front of a flower, and without alighting, inserting their rostrum and sucking the honey. A similar mode of taking food, and an equally rapid flight, being subsequently observed in the class more generally known as birds or fowls, the term *humming-bird* was extended to the genus *Trochilus* among feathered vertebrate animals. The larvæ have sixteen feet, and often a curved horn near the posterior extremity. They often raise up the anterior part of the body, giving somewhat the appearance of the Egyptian *sphinx*, which has become the name of one of the genera. The larvæ known as the tobacco-worm, which eat the leaves of growing tobacco, are those of Sphinx. The imago is often found about the flowers of *Datura stramonium* (or jimson weed). The posterior wings have a projection which passes through a ring upon the anterior ones, tending to keep the two together.

Chærocampa (*Ch. nerii*, *fig.* 21) is remarkable for the structure of the larva, the head and anterior part of the body being retractile. As in *Macroglossa*, the cocoon is placed upon the ground. *Deilephila* (*D. euphor-*

biæ, fig. 12; *D. elpenor, fig.* 13; *D. celerio, fig.* 14). The maxillæ are not very long in this genus. *Sphinx* (*S. pinastri, fig.* 11; *S. ligustri, fig.* 16; *S. convolvuli, fig.* 17). In this genus the spiral maxillæ are very long, and the antennæ somewhat lengthened, and hooked at the apex. Most of the caterpillars have oblique pale stripes upon the sides, and a horn near the posterior extremity. The pupæ have the rostrum case detached, and forming a hook. They change in the earth. *Sphinx carolina* and *S. quinque-maculata* are common in the United States. *Acherontia atropos* (*fig.* 15) is the largest member of this family in Europe. It is known by a mark upon the thorax in the shape of a human skull. *Smerinthus* (*S. tiliæ, fig.* 18; *S. populi, fig.* 19; *S. ocellata, fig.* 20) has the maxillæ very short, and the outer margin of the anterior wings irregular. The species are of sluggish habits, and do not feed upon the wing. The larva enters the ground to change, and the pupa is without the hooked rostrum case. Dr. T. W. Harris has published a valuable paper upon this family in the 36th vol. of the Am. Jour. of Science.

Macroglossa (*M. stellatarum, pl.* 80, *fig.* 10) is a day-flying genus having a tuft at the end of the abdomen. Its habits on the wing are those of *Trochilus*, with which it may be readily confounded.

Sesia fuciformis (*pl.* 80, *fig.* 9). This small group has no characters sufficient to separate it from the *Sphingidæ*, with which Westwood unites it. *Sesia* has the wings transparent, and the body robust and hairy. The species fly about flowers in the bright sunshine. This genus differs but little from *Macroglossa*, and both are called humming-birds.

Fam. 12. *Uraniidæ* (or *Nyctaloideæ*). These splendid insects have the general appearance of the diurnal Lepidoptera, except that instead of having the antennæ knobbed, the basal half is filiform, and the remainder gradually thickened, and then tapering to the point. The discoidal cell of all the wings is open. The chief color is a bright golden green, mixed with black and sometimes red. They fly during the day; and their flight is high and rapid, so that they cannot readily be taken except by rearing them from the larvæ.

Fam. 13. *Papilionidæ, Diurna*, or *Rhopalocera*. This family contains a great many large and beautiful insects which fly about in the brightest sunshine, but become dull in damp and cloudy days. They are sometimes of a large size, the expanse of the tropical genus *Ornithopterus* reaching ten inches. The colors are at times very gorgeous, reflecting like polished metal. The patterns are very various, composed of stripes, spots, or rings. Sometimes the lower surface of the wings differs but little from the upper one, but in other cases the pattern is very distinct. In most cases, the upper surface presents the most variety, and the brightest tints. The coloring is sometimes uniform through certain genera and groups: *Colias* being yellow and white, with the margins of the wings black; *Polyommatus*, blue; and *Argynnis* fulvous, with black spots above and silvery ones below. Butterflies seldom live over one season, but a few survive the winter and appear early in spring. Some are solitary, and others gregarious. The genus *Papilio* is very extensive, containing about three hundred

species. It is well represented in the United States, where it includes the large diurnal species. One of the most common is *Papilio turnus*, which is yellow, ornamented with black stripes, like *pl.* 80, *fig.* 48. The posterior edge of each posterior wing has a spatulate projection.

The group to which *Hesperia* (*H. malvarum*, *pl.* 80, *fig.* 22) belongs, sometimes have a small hook at the end of the knob of the antennæ, and the discoidal cell of the inferior wing is open. They fly about with a succession of jerks, and when they sit, the lower wings are held in a horizontal position. The larvæ are smooth, with a large head. That of *Eudamus tityrus* is green with the head rufous. It feeds upon the leaves of Robinia.

Lycæna hippothoë (*pl.* 80, *fig.* 23), *Polyommatus argiolus* (*fig.* 24), *P. argus* (*fig.* 25), *Thecla quercus* (*fig.* 27), *T. pruni* (*fig.* 28), *T. betulæ* (*fig.* 29). These insects (the *Lycænidæ* of Leach) are small and slightly made, with delicate marks and spots, the colors pale beneath and dark above, as brown in Thecla, coppery in Lycæna, and blue in Polyommatus.

Argynnis paphia (*pl.* 80, *fig.* 30), *A. aglaia* (*fig.* 31), *Vanessa c-album* (*fig.* 32), *V. atalanta* (*fig.* 33), *V. urticæ* (*fig.* 34), *V. antiopa* (*fig.* 35), *V. cardui* (*fig.* 38), *V. orithia* (*fig.* 41), *V. io* (*fig.* 42), *Apatura iris* (*fig.* 37), *Hipparchia semele* (*fig.* 39), *H. galathea* (*fig.* 40), *H. pamphilus* (*fig.* 43). These constitute a group, considered a family (Nymphalidæ) by some. They are finely ornamented, and the inferior surface is often marked with eye-like circles and silvery spots. The anterior feet are rudimentary.

Gonepteryx rhamni (*pl.* 80, *fig.* 44), *Colias hyale* (*fig.* 45), *Pontia cardamines* (*fig.* 46), belong to Westwood's sub-family *Pierides.*

Dorites apollo (*pl.* 80, *fig.* 47), *Papilio podalirius* (*fig.* 48), *P. machaon* (*fig.* 49), *P. æneus* (*fig.* 50), are typical members of the family.

Order 9. Hemiptera (*pl.* 80, *figs.* 52–77). This order is distinguished by the compound rostrum formed for piercing and sucking, and of which the lower lip incloses the mandibles and maxillæ, which are in the form of bristles. These insects live upon vegetable and animal juices, those which feed upon the former being the most numerous. The Linnæan name *Hemiptera* indicates a character which some members of the order possess, namely, a thickening of the basal portion of the anterior wings, whilst the remaining part is thin and transparent. Fabricius and Burmeister reject this name as inapplicable, and apply one (Rhynchota) founded upon the character of the mouth. The larva and pupa are active and take food at all times, so that the metamorphosis is not complete.

This order is divisible into two sections, according as the wings are of a uniform or varied texture; and this slight distinction has been taken as a sufficient basis to form these sections into orders named *Homoptera* and *Heteroptera.*

Blanchard divides the order into eight "tribes," of which the four first are homopterous and the four last are heteropterous, as follows: *Cocciniens*, *Aphidiens*, *Fulgoriens*, *Cicadiens*, *Nepiens*, *Reduviens*, *Lygéens*, *Scutelleriens.*

Burmeister divides the *Rhynchota* into tribes and families, as follows:

TRIBE (1). *Fam.* 1, *Pediculina.*
TRIBE (2). *Fam.* 2, *Coccina.*
TRIBE (3) PHYTOPHTHIRES. *Fam.* 3, *Aphidina*; 4, *Psyllodes.*
TRIBE (4) CICADINA. *Fam.* 5, *Cicadellina*; 6, *Membracina*; 7, *Fulgorina*; 8, *Stridulantia.*
TRIBE (5) HYDROCORES. *Fam.* 9, *Notonectici*; 10, *Nepini*; 11, *Galgulini.*
TRIBE (6) GEOCORES. *Fam.* 12, *Hydrodromici*; 13, *Riparii*; 14, *Reduvini*; 15, *Membranacei*; 16, *Caspini*; 17, *Lygæodes*; 18, *Coreodes*; 19, *Scutati.*

Westwood, who admits the *Homoptera* as a distinct order, divides them as follows:

SECTION 1. TRIMERA. *Fam.* 1, *Cicadidæ*; 2, *Fulgoridæ*; 3, *Cercopidæ.*
SECTION 2. DIMERA. *Fam.* 4, *Psyllidæ*; 5, *Aphidæ*; 6, *Aleurodidæ.*
SECTION 3. MONOMERA. *Fam.* 7, *Coccidæ.*

The *Heteroptera* he distributes as follows:

SECTION 1. HYDROCORISA. *Fam.* 1, *Notonectidæ*; 2, *Nepidæ.*
SECTION 2. AUROCORISA. *Fam.* 3, *Galgulidæ*; 4, *Acanthiidæ*; 5, *Hydrometridæ*; 6, *Reduviidæ*; 7, *Cimicidæ*; 8, *Tingidæ*; 9, *Capsidæ*; 10, *Lygæidæ*; 11, *Coreidæ*; 12, *Scutelleridæ.*

Fam. 1. *Coccidæ.* The principal genus of this family is *Coccus*, one of which (*Coccus cacti*, *pl.* 80, *fig.* 54 *a b*) has been named cochineal in commerce. This family was named *Gallinsectes* by Latreille, on account of the resemblance which the female bears to galls, neither wings nor articulate structure being present, the inert oval or hemispherical body being attached during life to the branch of a tree. They affix themselves by means of their rostrum, which is inserted so as to reach the sap, and their rudimentary feet when these are present. They resemble the lower crustacea in having a retrograde metamorphosis, the larvæ being active and capable of moving about to select a place upon which to affix themselves. The young remain for some time beneath the dead body of the female, which is well adapted for their protection. The males are active and winged, and their antennæ are longer than in the females. Some genera secrete from the skin a waxen or cottony substance which covers the body, and is often blown off by the wind in little flakes. In some genera the females are active.

Some of these insects increase rapidly, and are very hurtful to vegetation. *Coccus cacti*, on account of its beautiful crimson color, is used as a coloring material, and is extensively cultivated for this purpose, particularly in Mexico, its native country. It has been introduced into the Canary islands, Spain, Algeria, and St. Domingo, and it is cultivated in Guatemala

and Honduras. It is probable that it would flourish in the southern United States wherever the species of cactus suitable for its food are found. Humboldt calculated the annual amount of cochineal imported into Europe to be 800,000 pounds, and it requires about 70,000 insects to make a pound. Lac (or shell lac), which is used in making sealing-wax, varnishes, &c., is the product of a coccus. Manna has a similar origin; and a white wax is collected from another species. *Lecanium* (*figs.* 52, 53), *Dorthesia* (*fig.* 56), and *Chermes* (*fig.* 58), belong to this family.

Fam. 2. *Aphidæ* (*figs.* 57, 59). The plant lice, like the preceding family, are small insects which infest the tender shoots of vegetables, and by their numbers sometimes cause great damage. The body is robust, the head small, the antennæ seven articulate, the feet slender, the wings transparent, with few nervures, and the abdomen is sometimes provided with two tubular stylets connected with glands bearing a saccharine liquid, upon which the newly excluded young are said to feed, and which is eagerly sought by ants. The Aphides are generally without wings, although they are anomalous in sometimes having and sometimes being without them in the same species. The apterous individuals are generally females. The pupæ are active, and can be distinguished by their incipient wings, unless they are to produce wingless individuals. A single impregnation will fecundate several generations, the offspring being females which are capable of continuing the race. Kyber thus continued a species for four years, and Bonnet raised nine generations in three months. In some cases eggs are produced, and in others living young, and of these about ninety are produced at a time.

Fam. 3. *Psyllidæ* (*fig.* 55). A small family allied to the Aphides, but they are more active. They have ten articulate antennæ, the females have an ovipositor, and the male several abdominal appendages.

Fam. 4. *Cercopidæ.* This is an extensive and widely spread family of small and handsome insects, which suck the juices of plants, and are found abundantly in grass and low vegetation. The antennæ are tri-articulate, the stemmata two, the feet slender and adapted for leaping. The larva of Aphrophora (*fig.* 74) pierces small branches, and causes the sap to exude, which forms a mass of bubbles like spittle, under which the larva is hidden.

Fam. 5. *Membracidæ.* This family is closely allied to the preceding one in natural characters and habits, and is united with it by some authors. The pronotum is dilated so as to cover the posterior part of the body entirely or in part, forming a conspicuous object, and giving to some of these insects a very strange appearance.

Fam. 6. *Fulgoridæ.* This family is remarkable for the large projecting head, bright colors, and large size of some species. The Chinese *Fulgora candelaria* (*fig.* 76) is yellow, and the elytra black, marked with flavous spots. *F. laternaria* (*fig.* 77) inhabits South America.

Fam. 7. *Cicadidæ.* This family is named from the genus *Cicada* (*C. fraxini*, *pl.* 80, *fig.* 75), which has attracted attention from a remote period on account of the noise of the male. This sound differs considerably in the different species, that of *C. pruinosa*, Say, for example,

being very different from that of *C. septendecim*. The body is robust, the head large and triangular, with three stemmata, the eyes prominent, the antennæ short and thin, with six articulations, and the wings are large, and generally transparent.

The history of *Cicada septendecim*, known in the United States as the *seventeen year locust*, has been given in a valuable pamphlet by Dr. Potter, of Baltimore, who, deceived by the popular name, fancied that anything called *locust* must belong to the genus *Locusta*, and he accordingly names the insect *Locusta Septentrionalis Americanæ decem septima*, confounding these hemiptera with the grasshoppers, and naming the latter *Cicada*. Vernacular names being entirely independent of the scientific ones, attempts to make them correspond generally result in confusion. Dr. Harris gives some useful details in his Injurious Insects of Massachusetts, and Dr. S. P. Hildreth has written upon it in Silliman's Journal, vol. xviii. p. 47, and 2d Series, vol. iii. p. 216. See also vol. xiii. p. 224. The pupa of this insect leaves the ground in the Southern States in February and March, in Pennsylvania in May, and in Massachusetts in June. The female cuts openings with her ovipositor in the tender branches of trees, where her eggs are inserted; this causes the branches to die, and one observer relates an instance in which "the tops of the forests for upwards of a hundred miles appeared as if scorched by fire." It requires fifty-two days for the young to hatch, when they immediately precipitate themselves to the ground, which they enter and attack the roots, the juices of which they suck. Miss M. A. Morris (Proceed. Acad. Nat. Sci., vol. iv. pp. 132 and 190) has ascertained that these larvæ do much damage to fruit trees by their attacks upon the roots. She found them in great numbers upon all the roots which were more than six inches beneath the surface, and the trees were evidently suffering under their attacks. The larvæ were firmly attached to the roots by the insertion of their rostrum, and inclosed in a compact cell of clay without outlet, rendering it probable that they are sedentary where they first attach themselves. According to Miss Morris, they are destroyed by moles. The anterior feet of the larva and pupa are robust and adapted for digging, but those of the imago do not exhibit this character.

Fam. 8. *Notonectidæ* (*pl.* 80, *figs.* 72, 73). This family of small predaceous insects is named from the habit which the species have of swimming with the back below. They are aquatic, the head and eyes are large, the antennæ small, with four articulations, and the posterior feet are long and fringed, held out in repose like a pair of oars, and used like them in swimming. They are able to fly from one piece of water to another. *Corixa striata* (*pl.* 80, *fig.* 72 *a b*); *Notonecta glauca* (*fig.* 73).

Fam. 9. *Nepidæ* (*pl.* 80, *figs.* 68–71). This family is predaceous and aquatic, the species living at the bottom of quiet waters. The body is generally depressed, the antennæ about as long as the head, and inserted below the eyes so as to be hidden. The tarsi are dimerous, and the anterior feet raptorial. *Ranatra linearis* (*fig.* 68); *Nepa cinerea* (*fig.* 69); *Naucoris cimicoides* (*fig.* 70); *Belostoma* (*fig.* 71). The last genus

attains a length of three inches, and is sufficiently strong to kill small fish and frogs. Dr. Joseph Leidy has given the anatomy and characters of several North American species in the Journal Acad. Nat. Sci.

Fam. 10. *Galgulidæ.* *Galgulus oculatus* is a small North American insect, with an oval, depressed form, a broad head, and pedunculated lateral eyes. It may be seen during the day running along the grassy and sandy shores of rivers, but it is not aquatic, although it can swim to the shore if thrown into the water. It has the power of leaping a few inches, although the feet do not present saltatorial characters. When pursued they do not endeavor to escape by flight.

Fam. 11. *Hydrometridæ.* The members of this family live upon the surface of the water, over which some of them move with great rapidity. *Hydrometra* moves rather slowly over the surface, with the body elevated above it. The ordinary boat-shaped species, with four of the feet adapted to locomotion, belong to the genus *Hydrometra.* The larva of this genus has the abdomen very small, and as this is a characteristic of the corresponding oceanic genus *Halobates*, it sustains Professor Agassiz's view that freshwater forms are higher than marine ones. *Halobates* being rarely found with the wings developed, Westwood thinks they are not to be considered as imagos, especially as the abdomen is small; but an extension of the views of Agassiz affords a more satisfactory explanation. Many individuals of *Gerris*, which seem to be perfect, are without wings, and seem never to acquire any.

Fam. 12. *Leptopidæ.* This is a small family with the body oval and depressed, the eyes large, the feet slender, and the rostrum long. These insects are small and active, running and flying along the margins of water. The principal genus is *Salda*, improperly named *Acanthia* by Latreille, a name used previously by Fabricius for the *Cimex lectularius.* This family is named *Riparii* by Burmeister.

Fam. 13. *Reduviidæ.* This family includes active predaceous species with a short, stout rostrum, sufficiently strong to pierce insects with a tolerably hard integument. The head is narrow behind, forming a kind of neck, the eyes are prominent, and there are two stemmata. The North American *Arilus novenarius*, Say, Am. Ent., has the pronotum arched above, and notched like the cogs of a small wheel. The puncture of these insects is somewhat poisonous.

Fam. 14. *Tingidæ.* The species of *Tingis* have a small body with the wings strongly reticulated, and a membranous expansion upon each side of the prothorax. They move very slowly, and are found upon leaves, the juices of which they suck in all their stages. It is probable that the larvæ do not move from their first station. *Syrtis* is also very torpid in its movements; it lives upon trees, and probably feeds upon insects, as the anterior feet are very stout, and apparently raptorial. The genus *Acanthia*, first separated from the Linnæan genus *Cimex* by Fabricius, includes the bedbug, *Acanthia lectularia* (*pl.* 80, *fig.* 67). Amyot and Serville state that the name *Acanthia*, Fabr., 1776, must stand, being the first given after the dismemberment of the old genus *Cimex*, and on this account they

reject the name *Cimex*, which Olivier pròposed for the bedbug (or chinch) in 1789. They also reject *Pentatoma* of this author, using *Cimex* instead. Hist. Nat. des Ins. Hemipt., pp. 149, 311.

Fam. 15. *Capsidæ.* This family contains *Capsus*, *Phytocoris*, and other genera of small and ornamental insects found upon plants, upon the juices of which they seem to feed. They run and fly well; they have no stemmata, the ovipositor is contained in a groove of the abdomen, and the rostrum is four-articulate.

Fam. 16. *Lygæidæ.* This family is allied to the preceding, the species are small or of medium size, and the colors varied. They inhabit plants. *Pyrrhocoris apterus* (*pl.* 80, *fig.* 60).

Fam. 17. *Coreidæ.* The first articulation of the antennæ is as long as the head or longer, and the last one thickened or lengthened in this family. These insects are large, of varied colors and active habits, and they frequent plants. In some species the hind feet have various forms and foliaceous expansions. *Coryzus hyoscyami* (*pl.* 80, *fig.* 61).

Fam. 18. *Scutelleridæ.* Some of the members of this family have the scutellum so large as to cover the abdomen and wings. The body is robust, sometimes subglobular, the antennæ long, and the feet slender. Some of the species are above the medium size, and many of them are ornamented with brilliant colors. They are vegetable feeders, sucking the juices of leaves, and some of them have glands which secrete a fluid with a very disagreeable scent. There are three sub-families corresponding to the genera *Scutellera*, *Cimex*, and *Cydnus* (*fig.* 62). The first have a very large scutellum; the second and third a smaller one; and the third is distinguished from the second by having spinose feet. Fabricius left the name *Cimex* for insects subsequently named *Pentatoma*, with which Amyot and Serville agree, although they admit a genus *Pentatoma*. Other authors improperly reject the name *Cimex* entirely. *Cimex rufipes* (*pl.* 80, *fig.* 66). This species is also referred to the genus *Tropicoris* of Hahn, and to *Pentatoma*. *Pentatoma juniperinus* (*fig.* 63); *P. baccarum* (*fig.* 64); *Acanthosoma* (*fig.* 65).

Order 10. Strepsiptera. This order of Kirby was subsequently named *Rhipiptera* by Latreille. It includes a limited number of insects of small size, which are parasitic in the bodies of Hymenoptera. The anterior wings are replaced by a kind of twisted halteres, and the posterior ones are large and folded like a fan. The mouth has two small awl-shaped jaws, and two bi-articulate antennæ; the eyes are large, prominent, and lateral, with a few large facets, and these separated by partitions raised above their surface. The antennæ are simple or furcate, with few articulations; the thorax very robust, the metathorax very long, removing the posterior feet far back. The tarsi have from two to four articulations. Specimens of certain wasps and bees may be sometimes seen with the abdomen distorted, and an examination discloses one or more heads of a minute insect sticking from between the segments, which belong to these parasites when near the time of their appearance. Siebold has discovered the winged individuals to be males, and the females to be without wings, and

never leaving the wasp. The larvæ resemble minute parasites; they have six feet, and are active, running about to find an insect upon which they may become parasitic. When they have penetrated to a proper place they lose their feet and become larvæ of a different form, presenting an example of a retrograde metamorphosis.

Order 11. Diptera (*pl.* 77, *figs.* 87–129). In this order the body and integument are rather soft, the head generally free, and attached by a very short thin neck. The labium forms a kind of soft extensile rostrum adapted for suction; its sides are turned up to form a canal, and it incloses a varying number of sharp slender organs, sometimes adapted for piercing. These are well developed in the bloodsucking genera, in which the mandibles, maxillæ, labrum, and tongue are present. The two palpi of the *Diptera* are supposed to correspond to those of the maxillæ of the other orders, although the question is not settled. In some cases the mouth is obsolete. There are two or three stemmata; the eyes are large, being in some males larger than in the females, and in some cases they occupy nearly the entire head. The antennæ are sometimes composed of a succession of simple articulations, as in other orders; but in general they are short, composed of few articulations, the last of which bears a bristle (arista) on its upper surface. The prothorax is reduced to a narrow collar, the metathorax is also much reduced, having no wings, and bearing their representatives, the small knobbed organs named halteres, so that the thorax is made up chiefly of the mesothorax, which bears the single pair of wings, constituting the distinguishing character of the *Diptera*. The wings are absent in some cases, but the halteres are nearly always present. The precise use of the halteres is not known. They are vibrated in flight, and if they are removed an insect is prevented from flying. Many *Diptera* have a pair of single or double membranes (calypta) in connexion with the halteres, and varying in size in inverse proportion with them. The tarsi are pentamerous, and the abdomen has from four to seven segments apparent.

The pupæ of the *Diptera* are of two kinds: in one the integument of the larva is not cast, but contracts into the form of a cocoon, from the inside of which the pupa becomes disengaged; in the other the larva skin is cast, and the pupa takes the incomplete form (in which the limbs are visible) without a cocoon. In the *Culicidæ* the pupæ are active.

The larvæ are cylindric and without feet, the head corneous or fleshy, and the mouth is generally provided with a pair of hooks. The aquatic larvæ have jaws and palpi, and respiration is sometimes effected by means of tubes which are held at the surface of the water, and they swim with the aid of appendages at the posterior extremity.

The larvæ occur under various circumstances, as in carrion, fungi, in galls, like those of *Cynips;* or in living caterpillars, like *Ichneumon.* Some are to be found in vessels of vegetables pickled with vinegar, and others in the acrid brine of salted fish, or in the brine vats of salt works. The greater part are produced from eggs laid by the female; some are excluded alive; and in the *Pupipara* the young are not excluded until they have reached the pupa state.

In their perfect state the *Diptera* are found upon flowers or plants, feeding upon vegetable juices, or upon various decaying animal and vegetable products. Some suck the blood of vertebrate animals, or kill insects to suck their juices. They are very abundant, and are found in all climates, including the polar regions.

Although the *Diptera* are generally of a small size, they are so abundant in individuals that they occupy a prominent place in the economy of the animal creation. They fill the air in clouds, and afford food to various birds, whilst they are always ready to remove liquid decaying matter. The rapidity with which certain carrion flies increase under favorable circumstances, caused Linnæus to assert that three of them with their progeny can consume the carcase of a horse in as short a time as a lion would.

The *Diptera* contain a considerable number of noxious species, among which may be mentioned mosquitoes, the flies which torment cattle, bot-flies, and the grain flies which destroy wheat and other cereals.

Macquart divides the *Diptera* as follows, most of the names being latinized. The names between parentheses are called *families*, and the numbered names are given as tribes.

DIVIS. I. NEMATOCERA. Antennæ with at least six articulations, palpi with four or five.

SUBDIVIS. 1. RECTIPALPI. 1, *Culicidæ.*

SUBDIVIS. 2. CURVIPALPI. 2, *Chironomidæ;* 3, *Tipulidæ;* 4, *Mycetophilidæ;* 5, *Cecidomyiidæ;* 6, *Ryphides;* 7, *Phalænoides;* 8, *Bibionidæ.*

DIVIS. II. BRACHOCERA. Antennæ with three, and palpi with one or two articulations.

SUBDIVIS. 1. ENTOMOCERA; last articulation of the antennæ divided into segments. (TABANIENS.) 9, *Tabanidæ.* (NOTACANTHA.) 10, *Acanthomeridæ;* 11, *Sicarii;* 12, *Xylophagidæ;* 13, *Stratiomydæ.*

SUBDIVIS. 2. APLOCERA; last articulation of the antennæ not annulate.

§ TETRACHÆTES, mouth with four lancets. 14, *Midasidæ;* 15, *Asilidæ;* 16, *Hybotidæ;* 17, *Empidæ;* 18, *Vesiculosa;* 19, *Nemestrinidæ;* 20, *Xylostomes;* 21, *Leptides;* 22, *Bombylidæ;* 23, *Syrphidæ;* 24, *Dolichopidæ.*

§§ DICHÆTES, mouth with two lancets. (ATHERICERA.) 25, *Scenopinidæ;* 26, *Cephalopsidæ;* 27, *Lonchopteridæ;* 28, *Platypezidæ;* 29, *Conopsidæ;* 30, *Myodariæ;* 31, *Œstridæ;* 32, *Muscidæ.* (PUPIPARA.) 33, *Coriacea;* 34, *Phthiromyiæ.*

The following is Westwood's classification as given in his *Introduction.*

SECTION 1. CEPHALOTA, Westwood. Head distinct from the thorax; claws not dentated; larva annulose, not undergoing its transformations to the pupa state within the body of the parent; oviparous (or larvaparous in some *Muscidæ*).

DIVIS. 1. (*Stirps* 1.) NEMOCERA, Latr. Antennæ of more than six joints; palpi four- or five-jointed; pupa incomplete. *Fam.* 1, *Culicidæ:* 2, *Tipulidæ.*

Divis. 2. Brachocera, Macq. Antennæ short, not having apparently more than three distinct joints; palpi one- or two-jointed.

(*Stirps* 2.) Notacantha, Latr. Antennæ apparently composed of only three joints, the last, however, being articulated; proboscis exserted, seldom inclosing more than two lancets. The structure of the mouth is very incomplete, and the number of setæ variable. Pupa coarctate, the skin of the larva, however, nearly retaining its previous form. *Fam.* 3, *Stratiomydæ;* 4, *Beridæ;* 5, *Cœnomyidæ.*

(*Stirps* 3.) Tanystoma, Latr. Antennæ with only three joints, ordinarily terminated by a seta (*Tabanus* and *Midas* excepted); proboscis exserted, generally with four setæ (six in female *Tabanidæ;* mouth obsolete in *Acroceridæ*); larva with a scaly head; pupa incomplete. *Fam.* 6, *Tabanidæ;* 7, *Bombyliidæ;* 8, *Anthracidæ;* 9, *Acroceridæ;* 10, *Empidæ;* 11, *Tachydromiidæ;* 12, *Hybotidæ;* 13, *Asilidæ;* 14, *Mydasidæ;* 15, *Therevidæ;* 16, *Leptidæ;* 17, *Dolichopidæ;* 18, *Scenopinidæ.*

(*Stirps* 4.) Athericera, Latr. Antennæ with only two or three joints, terminated by a seta; proboscis generally withdrawn into the oral cavity, with two setæ (four in the *Syrphidæ;* mouth obsolete in the *Œstridæ*); pupa coarctate, the skin of the larva forming an oval case. *Fam.* 19, *Syrphidæ;* 20, *Conopidæ;* 21, *Muscidæ;* 22, *Œstridæ.*

Section 2. Thoracocephala. (*Stirps* 5.) Pupipara, Latr. (Order *Homaloptera,* Leach). Head immersed in the thorax; claws denticulated; larva nourished in the abdomen of the mother, and not deposited until after it has passed to the pupa state. *Fam.* 23, *Hippoboscidæ;* 24, *Nycteribiidæ.*

The first section includes a great majority of the Diptera (including those to which the term *fly* is popularly assigned), in which the head and antennæ are free. The mouth is a soft rostrum, containing several bristle-shaped organs in a groove along its upper surface, which also forms a channel for the liquid food.

The *Culicidæ* is a family of which *Culex* (including the mosquitoes) is the best known genus, and notwithstanding their small size, their organization is very perfect. The rostrum is very long and slender, apparently simple, but composed of seven organs. The male, which does not sting, can be readily distinguished by the feathery antennæ. These tormenting insects do not move about much during the day; but where they abound, as soon as the sun sets, they fill the air in myriads, and become a serious evil. They abound in warm climates; and in the low regions of the lower Mississippi, they fill the houses and the cabins of the steamboats as evening advances. In many parts of the United States it is necessary to exclude them from beds by a netting of gauze called a *mosquito bar.* In districts where they are rare, a house may be infected with them from a vessel used to catch rain water, and in which a passing female may deposit her eggs. These are laid upon the surface of stagnant water one at a time, but in contact with each other, and to the number of two or three hundred. In two days the larva make their appearance, in fifteen days they become

pupæ, and instead of respiring through the posterior extremity, they have two horn-like tubes on the thorax for this purpose. The pupæ are active, but do not take food. The entire period required for the transformations is about three weeks. *Culex* (*pl.* 77, *figs.* 95, 96), *Anopheles* (*fig.* 94).

The *Tipulidæ* are an extensive family, which bear a considerable resemblance to the Culicidæ, on account of their slender body and feet. The rostrum is short, robust, and ending in a pair of fleshy lips; the palpi are generally four-articulate, and turned back. The abdomen of the male is often thickened at the tip, the antennæ have in general from fourteen to sixteen articulations, those of the male being often verticillate or pectinate. The larvæ of some are aquatic; some live in the ground, where they destroy the roots of grass; some in fungi or decaying matter, and some in galls. The minute but destructive insects of the genus *Cecidomyia* (Hessian fly) belong to this family. There are several sub-families which Westwood names *Chironomides*, *Cecidomyides*, *Mycetophilides*, *Tipulides*, and *Bibionides*. The genera figured are, *Chironomus* (*pl.* 77, *fig.* 118), *Anisomera* (*fig.* 119), *Ctenophora* (*fig.* 120), *Psychoda* (*fig.* 121), *Mycetophila* (*figs.* 122, 124), *Bibio* (*fig.* 123).

The *Stratiomydæ* are generally gaudily colored; they are found upon flowers, and have the body usually depressed, and the scutellum often spinose. The larvæ are aquatic or terrestrial, and the pupa is formed within the skin of the larva. *Stratiomys* (*pl.* 77, *fig.* 117), *Clitellaria* (*fig.* 110).

The *Tabanidæ* have the eyes large, the mouth well developed, that of the female having six and that of the male four piercers. The labium is fleshy, with the end lobed; and the palpi have two articulations, of which the second is long. *Tabanus* (*T. tropicus*, *fig.* 97, *T. bovinus*, *fig.* 98) has the third articulation of the antennæ excised upon one side. The genus contains some of the largest of the Diptera, and from their size, number, and the perfection of their oral organs, they are a great pest to cattle when numerous. The males frequent flowers, the females alone sucking blood.

The *Bombyliidæ* (*Bombylius*, *pl.* 77, *fig.* 87) resemble certain bees, and the analogy is preserved by the buzzing sound they make in flying. The rostrum is very long, and projecting in front, and with this they suck flowers without alighting. Their wings stand horizontally, and their flight is very rapid.

In the *Empidæ* (*figs.* 92, 93) the body is narrow, the head small and round, with a distinct neck, the wings are large, and the feet generally long. The males generally live upon honey, and the females upon the juices of insects which they take on the wing with the aid of their feet.

The *Asilidæ* include several large predaceous Diptera, with a slender bristly body, a depressed head, bearded below, and a robust thorax. They fly with a buzzing noise, and take other insects upon the wing. The larvæ feed upon roots. *Dioctria* (*fig.* 88), *Asilus* (*fig.* 89).

The *Midasidæ* contain a number of very large Diptera with clubbed antennæ. *Midas filatus* (black, with a transverse orange band near the base of the abdomen) inhabits the United States.

Leptis (*fig.* 116) is the representative of a family (*Leptidæ*) of small flies of varied colors. In this genus the head is depressed, the antennæ end in a bristle, and the thorax is tuberculate.

The Athericera contain the four families *Syrphidæ*, in which the labium incloses four setæ; *Conopsidæ*, *Muscidæ*, having two setæ; and *Œstridæ*, with the mouth obsolete.

The *Syrphidæ* are tolerably large variously colored flies, which move swiftly through the air, and often hover over a spot for some time without changing their position. They have a hemispherical head, a great part of which is taken up by the eyes, a soft rostrum elbowed towards the base, with a pair of lip-like expansions at the tip, and the palpi small and inarticulate.

The genus *Volucella* (*V. pellucens*, *pl.* 77, *fig.* 111) is remarkable for its resemblance to the genus *Bombus* (bumble bee), which was designed to enable it to reach without suspicion the nests of the latter, in which the larvæ are parasitic, feeding upon the larvæ of the bees.

The eggs of *Syrphus* are deposited among the Aphides, upon which the larvæ feed. Other larvæ are vegetable feeders, and those of *Eristalis* (*E. tenax*, *fig.* 114) and *Helophilus* (*fig.* 115) are aquatic, and have the posterior part of the body attenuated into a breathing tube. These leave the water to transform in the ground. *Scæva pyrastri* (*fig.* 112), *Chrysotoxum* (*fig.* 113).

The family *Conopsidæ* (*Conops macrocephala*, *fig.* 90) are parasitic in the nests of bees in the larva state, and the imagos frequent flowers. Latreille reared a species which was parasitic in bees, and we have met with a living grasshopper in Pennsylvania, with the abdomen filled with several dipterous larvæ which we did not succeed in rearing. They may have belonged to this genus, or to *Tachinus*. Latreille placed the genus *Stomoxys* (*S. calcitrans*, *fig.* 91) in this family.

The family *Muscidæ* (*figs.* 101, 103, 106, 108) is very extensive, and contains many minor groups. The habits of the species are very various. *Sarcophaga carnaria* (*fig.* 109) deposits its larvæ upon rotten vegetables, caterpillars, and even on earthworms, which they penetrate, leaving their posterior extremity at the surface. Several genera deposit their eggs upon flesh the moment it has become tainted; and *Tachina* and allied genera resemble the *Ichneumonidæ* in being parasitic in other living insects. *Musca domestica*, the house fly, accompanies civilized man in his migrations. The transformations of this species are said to take place in dung. Various larvæ attack different kinds of fruits, roots, and branches, causing galls, and decaying vegetable matter of different kinds. The larva of *Piophila casei* (*fig.* 103) infests cheese, and that of *P. petasionis* is found in preserved hams. Both are known as skippers. The larvæ of *Oscinis* and *Chlorops* are destructive to growing grain.

The *Œstridæ* (*figs.* 125–129) are a singular family of flies which live at the expense of different Mammalia, each species being generally confined to a single species of the latter. Among the animals subject to their attacks are the horse, ass, ox, various species of deer and antelope, camel, hare, and in Peru there is a species which attacks man under the skin. Animals which do not fear ordinary biting flies, often exhibit great uneasiness and terror at the presence of these insects. The larvæ occur in three different modes, some in subcutaneous tumors, as in oxen; some in the head, as that of the sheep; and some in the stomach, as in the horse. The eggs of the first kind (as *Œstrus bovis*, *fig.* 129) are deposited on the skin; those of the second (as *Cephalemyia ovis*, *fig.* 125) within the nostrils; and those of the third (as *Gasterophilus equi*, *fig.* 127) upon the hairs of those parts which can be reached by the tongue of the animal, or about the nostril, as in the case of *Gasterophilus nasalis*.

The moisture and warmth of the mouth of the horse hatch the eggs of *Gasterophilus equi*, when the larva passes to the stomach with the food. Here it affixes itself to the inner surface by means of a pair of oral hooks, forming a little cavity for its head. The eggs are mostly laid in August, and the larva remains upon the stomach until the next summer, when it is an inch long. It now detaches itself and is passed through the intestines, when it becomes a pupa in the ground, and in the course of a few weeks it emerges as a fly. The male dies after fecundation, and the female after depositing her fifty or a hundred eggs. The larvæ sometimes affix themselves to the windpipe, or pass on to the small intestines, when a horse is apt to die from the irritation, and in a few cases they perforate the stomach. In most cases the presence of bots (as these larvæ are named) causes no injury to a horse, and their head is so deeply imbedded that no medicine sufficiently active for their expulsion can be administered with safety.

The presence of *Cephalemyia ovis*, or the fly of the sheep, puts the animals to flight and causes them to huddle together upon some sandy or bare spot (as if to prevent the fly from having a resting place), with their heads down and turned together, and their feet in continual motion to keep it from effecting its object. The fly, however, by a rapid dart, reaches the nostril, where it deposits an egg, the larva of which ascends the nostril, causing great uneasiness to the sheep, which runs around with every mark of distress. The larva makes its way to the frontal sinus, the antrum, or the nasal bones, where it affixes itself with its oral hooks, and remains until the next spring, when it crawls out and enters the ground to change. It remains in the earth six or eight weeks in the pupa state, and when it becomes an imago it is as short-lived as the horse bot-fly.

The *Œstrus bovis*, the larva of which lives beneath the skin of the back in oxen, causes great terror among these animals, which run for protection to bodies of water. The larvæ of *Œstrus tarandi* (*fig.* 128) are found under the skin of the reindeer. Another member of the family infests the frontal sinus, throat, and mouth (under the tongue) of the same animal.

The *Pupipara* are a singular group of insects, having the antennæ (which are of one or two short articulations) deeply set in the head. The mouth is without a fleshy exsertile labium, but it is provided with a sharp spicula and several bristles. They are separated into two families, *Hippoboscidæ* and *Nycteribiidæ*.

The *Hippoboscidæ* have a depressed, tough, and hairy body, and they live upon beasts and birds, moving quickly (and sometimes sideways) among the hair and feathers. The wings, and even the halteres, are sometimes absent, as in *Melophagus ovis* (*pl.* 77, *fig.* 85), known as the sheep tick. The feet are short, and the claws denticulated. The larva remains unexcluded until it becomes a pupa, and as but one is developed at a time, it is, when excluded, nearly as large as the abdomen of the female.

The *Nycteribiidæ* are without wings and halteres, the feet are very long, and so is the basal articulation of the tarsi, which present an analogy with the feet of some of the Arachnida in being annulated, presenting the appearance of being divided into numerous minor parts. These insects infest bats; and from the position of the head, which is small and turned up on the thorax so as to be dorsal, it is necessary for them to turn over and stand with the back downwards when they suck. This is readily effected, the feet being so constructed as to allow them to stand erect or inverted. They move rapidly through the hair, but cannot walk upon a smooth surface. Some authors have classed these insects with the Arachnida.

VERTEBRATA.

Class I. Pisces. Fishes.

The animals of this class are distinguished from those already examined, by their countless numbers, their varied shapes, their brilliant colors, and especially by their economical value. Destined by nature to inhabit and people the water, all their structures and functions tend to this end. Their most general characteristics lie in the possession of cold red blood, breathing by gills instead of lungs, a bicamerated or two-chambered heart, fins as organs of progression, and a skin either naked or covered with scales of varied structure.

To consider these characteristics more closely, the fins consist of a delicate membrane investing a series of bony or cartilaginous rays, projecting from the body along the median line, and from the four homologues of the extremities of the terrestrial vertebrata. They have received names derived from their situation upon the body. The *dorsal fin* is on the median line of the back, usually single, sometimes sub-divided into two or three fins, of various degrees of contiguity. The *caudal fin* terminates the vertebral column in the median line, and is situated in a vertical plane; the true fishes differing in this respect from the fish-like mammalia, the caudal fin in the latter being placed horizontally. The third median single fin is the *anal*, situated anteriorly to the caudal, on the anterior median line. This also is sometimes divided into two or more portions. The remaining four fins, two *pectoral* and two *ventral*, situated in pairs, are the homologues of the anterior and posterior extremities of the other vertebrata. Their relative positions may vary, but they are always found rather on the inferior surface, between the anal fin and the head. The pectoral fins are always situated just behind the head, and are articulated directly to the skull. The ventrals may be entirely posterior to the pectorals, exactly inferior to them, or entirely anterior and under the throat. The fins serve as organs of motion, and to sustain the fish in an upright position. The principal instrument of motion is the caudal fin, which, by its rapid and vigorous strokes from one side to the other, causes the animal to move forwards in a straight line, the resultant of this lateral flexion. The median fins serve to balance the fish; the pectorals and ventrals, although to a certain extent instruments of motion, yet act almost entirely in balancing the fish, and diverting its course to the right or left, as also to regulate the rising and sinking in the water. Sometimes the rays of several of the fins are thickened into regular spines, retaining, to a greater or less extent, the proper integument. Fins without distinguishable rays, or where the rays are enveloped in a mass of fatty

matter, or else entirely wanting, are called *adipose.* A fin of this character is found on the back of the trout (*Salmo fontinalis*) posterior to the main dorsal.

The *gills* consist of bony or cartilaginous spines, arranged parallel to each other, like the teeth of a comb; over which run blood-vessels from the heart, for the sake of the purification to be experienced by contact with the oxygen dissolved in the water. Sometimes the gills, instead of being pectinate, are arranged in bunches. The *gill-cover* consists of four bones, of which the one immediately behind the orbit is called the *pre-operculum.* Posterior to this are the *operculum* and *inter-operculum,* the former above the latter. Inferior to these, or slightly posterior, is the *sub-operculum.* Anterior to the lower part of the opercular bones is the branchial membrane, supported by the branchiostegous rays. In cases where the gill-covers are wanting or concealed, there are generally five to seven apertures in each side. Respiration in the fish is performed by taking in water through the mouth, and forcing it through the gill-openings by muscular contraction. By the contact of water with the venous blood in the gills, oxygen is imparted, and the requisite decarbonization effected. The entire circulation of the blood is as follows: Venous blood collected from the venous system, is accumulated in the single auricle. Thence it is forced into the ventricle, and this drives it into the gills. Here the blood is changed from venous to arterial, and is distributed to the different parts of the body. The heart thus never contains any but venous blood, the arterial first proceeding from the gills.

The swimming bladder of the fish is the true homologue of the lungs in the higher vertebrata; a fact well shown by its intermediate character in *Amia* and other fishes. Whenever present, it appears to contribute, to a greater or less extent, to the function of respiration. It exhibits various forms, bi-lobed, bi-partite, &c., and in the young fish, or even in some adults, there is a distinct communication by a tube with the œsophagus, answering to the trachea. It usually contains a gas, with oxygen in greater proportion than in atmospheric air. Some species are destitute, either entirely, of an air-bladder, or possess it in a very rudimentary state, as in *Cobitis.* Those without it are generally ground fish, which keep close to the bottom. Besides the use of the air-bladder in respiration, it serves an important purpose in enabling the fish to vary its specific gravity, and thus float at any desired elevation in the water.

The body of the fish, with a few exceptions, is longer than broad, and compressed. There is little expression in the face, the features being on the same level, and the nose not projecting. The line of distinction between the head and body is difficult to draw, owing to the entire absence of neck. The heart is situated far forward, between the branchial apparatus. The simple brain does not fill the cavity of the cranium. The tongue is mostly cartilaginous, sometimes covered with teeth. The salivary glands are inconspicuous, and it is not probable that the fish possesses much sense of taste. There is no external ear, and the entire auditory apparatus is here at its minimum of vertebrate development; although not so simple as

in the Cephalopoda. The eyes are characterized by their immovable position, flattened cornea, spherical crystalline lens, and brilliant color, as well as by certain internal anatomical peculiarities. The organs of touch lie either in the lips, or in the apparently sensitive barbels or cirri so conspicuous in some species.

The teeth are rarely entirely wanting, although sometimes absent from the mouth. In this case they are generally to be found in the posterior arch of the gills, when they are called pharyngeal teeth. Such is the case in most of the *Cyprinidæ*. Some fish have teeth in nearly every bone in the mouth; on the maxillary, intermaxillary, palatine, vomerine, spheroidal, as well as on the tongue and gill arches. The shape of the teeth, as also their disposition, varies greatly.

As already remarked, the skin is either naked, or covered with scales; these occurring in various conditions of development, as true imbricated scales, as isolated scales, as spiny prickles, bristles, hard bony enamelled plates, &c. The side of the fish generally exhibits a longitudinal row of scales, in each of which is a perforation. These holes, constituting by their linear arrangement, the *lateral line* of the fish, were formerly supposed to secrete mucus. The recent researches of Professor Agassiz have, however, shown that these are the openings of tubes, which, together with similar tubes opening on the skull, penetrate all parts of the body, brain, muscles, bones, and viscera; freely admitting water, whose hydrostatic action thus equalizes the pressure of the incumbent water, both on the outside and within.

The colors of fishes are among the most beautiful in nature, being only assimilated, and that in an inferior degree, by those of birds. All shades are represented, as well as all lustres. These hues, however, are very evanescent, sometimes departing immediately after death.

The *organs of voice* are entirely wanting, and there are but few that are capable of making any sound whatever. The North American cat-fish (*Pimelodus*) is said to make a peculiar sound by a vibration of its cirri. The weak fish (*Otolithus regalis*) makes a peculiar grunting when caught, apparently abdominal in its character. The same applies to the black drum (*Pogonias chromis*).

While some fish are confined to salt water, and others to fresh, certain species live habitually in a mixture of the two. Others again, at different seasons of the year, occupy both salt and fresh, as the salmon. The distribution of species is much affected by the temperature of the water, and the character of the bottom. But few fishes can live out of water for any length of time, owing to the rapid desiccation of the gills, and the consequent asphyxia. The eel and the cat-fish (*Pimelodus*) can exist for some days in a simply moist or damp situation, as wet grass. Certain species, as the *Anabas*, habitually leave the water in search of food.

Fishes are almost incredibly prolific. It has been calculated that the progeny of a single herring, allowed to reproduce and multiply undisturbed for twenty years, would not only supply the whole earth with an abundance of these fish, but would become inconveniently numerous. Yet among

millions of young herrings, hardly one comes to maturity, owing to the ravages made among their number by the rapacious fish and other animals, man not excepted. Yet although they form the food of myriads of fishes, of hundreds and thousands of men, the supply is always equal to the demand, and no perceptible decrease in number can be observed. Similar instances might be furnished by the cod, the shad, the mackerel, &c.

Of all oviparous animals, fish are perhaps the most prolific. Among these the cod-fish (*Morrhua*) is pre-eminently conspicuous. A single female has been calculated to produce as many as 9,000,000 eggs in a single season. There is no intercourse of sexes, excepting among a few of the *Plagiostomes*, the eggs being fertilized by the male after their evacuation by the female. Some species are ovo-viviparous, the eggs being hatched in the abdomen, or else in especially contrived pouches, as in *Syngnathus*. A slight approach to a placental connexion of mother and embryo, is made in some of the sharks. The eggs are deposited in various places, on sticks, stones, grass, in furrows of the sand, &c.; in rare cases a nest is built, consisting either of a single pile of stones, as in some of the North American *Cyprinidæ*, or else a more complicated structure of grass and sticks is built, as in the *Callichthys* of Demerara, and in various species of *Gasterosteus*. It is a little singular, that it is generally the male who takes upon himself the care of the eggs and the construction of the nest.

It is difficult to speak with any certainty as to the longevity of fishes, as few are permitted to reach their natural term of years. Some species, as *Pike* and *Carp*, kept in fish ponds, have, however, been known to live to a great age. Thus Buffon speaks of carp, in the moat of the Comte de Maurepas, 150 years old. Gesner refers to a pike having been caught in Suabia, in 1497, bearing an inscription purporting to have been appended in 1230, the age thus being (at least) 267 years. The animal was said to weigh 350lbs., and to have a length of nineteen feet.

The flesh of most fishes is edible, although that of some is difficult of digestion. They are rarely, or never, poisonous in themselves; a property only acquired by consuming poisonous plants or animals. Fresh-water fishes are more generally edible than marine, although, as a class, not so savory. Other parts of the fish are of economical value besides the flesh. The oil of some is very valuable; the air-bladder of the sturgeon furnishes the isinglass of commerce; the roes of the sturgeon, pike, carp, &c., furnish caviar. The shagreen skin of some *Placoids* is used for polishing, and for making ornamental coverings. The bones are used for fish-hooks, and other purposes. The *Gymnotus* or electric eel, the *Torpedo*, and the *Silurus electricus*, are capable of giving powerful electric shocks.

Classification of Fishes.

The first scientific classification of fishes is that of Artedi (1738), who distinguishes them into cartilaginous (*Chondropterygii*) and bony; these being subdivided into fishes with bony branchiæ and soft fin rays (*Mala-*

copterygii), or with spinous rays (*Acanthopterygii*), and fishes with boneless branchiæ (*Branchiostegi*). Fifty-eight genera were distributed under these four heads, corresponding for the most part with those of Linnæus, whose arrangement comes next in order. This is based upon the position of the vertical fins, or the structure of the gills. The following tabular view exhibits the orders of Linnæus, with the genera of each order, taken from the thirteenth edition of 1767.

I. Apodes. *Ventral fins none.*

1. Muræna.	4. Anarhichas.	7. Stromateus.
2. Gymnotus.	5. Ammodytes.	8. Xiphias.
3. Trichiurus.	6. Ophidium.	

II. Jugulares. *Ventral fins before the pectoral.*

9. Callionymus.	11. Trachinus.	13. Blennius.
10. Uranoscopus.	12. Gadus.	

III. Thoracici. *Ventral fins under the pectoral.*

14. Cepola.	20. Zeus.	26. Perca.
15. Echineis.	21. Pleuronectes.	27. Gasterosteus.
16. Coryphæna.	22. Chætodon.	28. Scomber.
17. Gobius.	23. Sparus.	29. Mullus.
18. Cottus.	24. Labrus.	30. Trigla.
19. Scorpæna.	25. Sciæna.	

IV. Abdominales. *Ventral fins behind the pectoral.*

31. Cobitis.	37. Fistularia.	43. Mormyrus.
32. Amia.	38. Esox.	44. Exocætus.
33. Silurus.	39. Elops.	45. Polynemus.
34. Teuthis.	40. Argentina.	46. Clupea.
35. Loricaria.	41. Atherina.	47. Cyprinus.
36. Salmo.	42. Mugil.	

The remaining genera were arranged under the head of *Amphibia*, as *Amphibia nantes*, and characterized by having fixed gills without a bony structure.

V. Spiracula Composita.

48. Petromyzon.	50. Squalus.	51. Chimæra.
49. Raja.		

VI. Spiracula Solitaria.

52. Lophius.	56. Ostracion.	59. Centriscus.
53. Acipenser.	57. Tetraodon.	60. Syngnathus.
54. Cyclopterus.	58. Diodon.	61. Pegasus.
55. Balistes.		

The classification of Cuvier is the one more generally adopted. He divides the entire class into bony and cartilaginous; the former again into spinous rayed and soft rayed; the latter into those with free gills, and such as have them fixed. We have here room only for the *Orders* and *Families.*

I. Acanthopterygia. *Fin rays spinous.*

Percidæ.	Chætodontidæ.	Mugilidæ.
Triglidæ.	Scombridæ.	Gobidæ.
Sciænidæ.	Teuthidæ.	Lophidæ.
Sparidæ.	Tænidæ.	Labridæ.
Mænidæ.	Atherinidæ.	Siluridæ.

II. Malacopterygii Abdominales. *Fin rays soft. Ventrals behind the pectoral.*

Cyprinidæ.	Fistularidæ.	Clupeidæ.
Esocidæ.	Salmonidæ.	

III. Malacopterygii Subbrachiati. *Fin rays soft. Ventrals beneath the pectoral.*

Gadidæ.	Cyclopteridæ.	Echineidæ.
Planidæ.		

IV. Malacopterygii Apoda. *Fin rays soft. Ventrals wanting.*

Anguillidæ.

V. Lophobranchii. *Gills in tufts; not pectinate.*

Syngnathidæ.

VI. Plectognathi. *Bones of the head closely combined.*

Gymnodontidæ.	Balistidæ.	Ostracionidæ.

VII. Chondropterygii Branchiis Liberis. *Gills pectinate, free. A single gill opening.*

Sturionidæ.

VIII. Chondropterygii Branchiis Fixis. *Gill apertures more than one on each side. Gills not free.*

Squalidæ.	Raiadæ.	Petromyzonidæ.

A highly philosophical classification is that of Prof. Agassiz, which is especially applicable to the arrangement of fossil forms. This eminent naturalist divides fishes into four Orders from characters derived from the scales. They are as follows:

I. Placoids. Characterized by having the skin provided with osseous plates of various sizes and numbers, as in the sharks, rays, &c. The

Plagiostomes of authors fall under this order. The families are: *Rajacei, Cestraciones, Hybodontes, Squalini, Chimæræ, Ichthyodorulithes.*

II. Ganoids. Here the scales are bony and covered externally with enamel, generally angular and continuous. Most Ganoids are extinct; the most striking and typical recent representation is the *Lepidosteus* or gar-fish. Families: *Sturionini, Lophobranchii, Gymnodontes, Sclerodermi, Cephalaspides, Pycnodontes, Cœlacanthi, Sauroidei, Lepidosteini.*

III. Ctenoids. This order corresponds nearly to the *Acanthopterygii* of Cuvier. It is characterized by the roughness of the scales, the border of which is generally dentated, and by the usual presence of spinous rays in the dorsal and anal fins. Families: *Mugiloidei, Aulostomi, Pleuronectidei, Squamipennes, Theutyes, Gobioidei, Sciænoidei, Sparoidei, Percoidei.*

IV. Cycloids. These are represented by the greater number of the *Malacopterygii* of Cuvier. The scales are generally smooth, and not dentated. The dorsal and anal fins have generally soft rays. Families: *Anguilliformes, Halecoidei, Esocini, Cyprinodontes, Cyprini, Labroidei, Lophioidei, Blennioidei, Sphyrænoidei, Xiphioidei, Scomberoidei.*

The most recent classification of fishes is that of Prof. J. Müller (Ueber den Bau und die Grenzen der Ganoiden u. über das natürliche System der Fische. 1846). We append a brief summary of this system as modified by several authors.

Order I. Dermopteri.

Internal skeleton unossified: external skeleton and vertical fins mucous, naked. Shape vermiform, or without any lateral fins. No pancreas nor air-bladder.

Sub-order 1. *Pharyngobranchii.*

Amphioxidæ.

Sub-order 2. *Marsipobranchii.*

Myxinoidei. Petromyzontidæ.

Order II. Malacopteri.

Internal skeleton ossified. Scales of the external skeleton mostly cycloid, in some ganoid. Fins all supported by rays, all of these jointed excepting sometimes the first in the dorsal and pectoral; abdominal or apodal. Gills free, operculate. A swimming bladder and air duct.

Sub-order 1. *Apodes.*

Symbranchidæ. Murænidæ. Gymnotidæ.

Sub-order 2. *Abdominales.*

Clupeidæ.	Galaxidæ.	Cyprinodontidæ.
Salmonidæ.	Esocidæ.	Cyprinidæ.
Scopelidæ.	Mormyridæ.	Siluridæ.
Characini.	Hypsocidæ.	

Order III. Pharyngognathi.

Internal skeleton ossified. Scales sometimes cycloid, sometimes ctenoid. Inferior pharyngeal bones coalesced. Air-bladder without a duct in the adult.

Sub-order 1. *Malacopterygii.*

Scomberesocidæ.

Sub-order 2. *Acanthopterygii.*

Chromidæ.	Cyclo-Labridæ.	Cteno-Labridæ.

Order IV. Anacanthini.

Internal skeleton ossified. Scales sometimes cycloid, sometimes ctenoid. Fins sustained by flexible or jointed rays. Ventrals beneath the pectorals or entirely absent. Swimming bladder without air-duct.

Sub-order 1. *Apodes.*

Ophididæ.

Sub-order 2. *Thoracici.*

Gadidæ.	Pleuronectidæ.	Echineidæ.

Order V. Acanthopteri.

Internal skeleton ossified. Scales ctenoid. Fins with one or more of the anterior rays unjointed or inflexible. Ventrals generally beneath or anterior to the pectorals. Swimming bladder without duct.

Percidæ.	Atherinidæ.	Theutyidæ.
Sclerogenidæ.	Mugilidæ.	Fistularidæ.
Sciænidæ.	Notacanthidæ.	Gobiidæ.
Labyrinthi-branchii.	Scomberidæ.	Blenniidæ.
Sparidæ.	Squamipennes.	Lophiidæ.
Mænidæ.	Tænioidei.	

Order VI. Plectognathi.

Internal skeleton only partly ossified. Scales ganoid or spinous. Maxillaries and intermaxillaries firmly united. Swimming bladder without air-duct.

Balistidæ.	Ostracionidæ.	Gymnodontidæ.

ORDER VII. LOPHOBRANCHII.

Internal skeleton only partly ossified. Scales ganoid. Gills tufted, gill-opening small. Swimming bladder without air-duct.

Hippocampidæ. Syngnathidæ.

ORDER VIII. GANOIDEI.

Internal skeleton bony or cartilaginous. Scales ganoid. First fin-ray usually a spine. Swimming bladder with an air-duct.

Sauridæ.	Sturionidæ.	Cephalaspidæ.
Pycnodontidæ.	Acanthodei.	
Lepidoidei.	Dipteridæ.	

ORDER IX. PROTOPTERI.

Internal skeleton partly bony, partly cartilaginous. Scales cycloid. Pectorals and ventrals as flexible filaments. Gills filamentary, free. No pancreas. Swimming bladder as a double lung, with an air-duct. Intestine with a spinal valve.

Sirenoidei.

ORDER X. HOLOCEPHALI.

Internal skeleton cartilaginous. External skeleton as placoid grains. Most of the fins with a spinous first ray ; ventrals behind the pectorals. Gills laminated, attached by their margins ; a single external aperture. No swimming bladder. Intestine with a spiral valve. Copulation between the sexes.

Chimæroidei. Edaphontidæ.

ORDER XI. PLAGIOSTOMI.

Internal skeleton cartilaginous, or partly ossified. External skeleton placoid. Gills fixed ; with five or more gill-openings. Swimming bladder none. Scapular arch not attached to head. Ventrals behind the pectorals. Intestine with spiral valve.

Hybodontidæ.	Lamnidæ.	Rhinobatidæ.
Cestraciontidæ.	Alopeciidæ.	Torpedinidæ.
Notodanidæ.	Scymniidæ.	Raiidæ.
Spinacidæ.	Squatinæ.	Trygonidæ.
Scylliidæ.	Zygænidæ.	Myliobatidæ.
Nictitantes.	Pristidæ.	Cephalopteridæ.

We come in the next place to the consideration of the more prominent of the families above mentioned; taking them up in the order in which they occur in the system of Müller, as modified above, and which we shall for the most part adopt. The subject of *Ichthyology* is of such vast extent, that our limits would be transgressed even by mentioning the names alone of all the species. We can only refer particularly to the species distinguished by their economical value or physiological interest.

Amphioxidæ. This family, at present represented by the single genus *Branchiostoma*, occupies the lowest position in the scale of fishes. It is characterized by the naked skin, the single dorsal extending over the entire length of the back, the absence of pectorals and ventrals. Mouth entirely inferior, elongated, or circular, the margins provided with a row of free filaments. Anterior to the anus is a median fin representing the transition embryonic fin of higher fishes. The brain, as an expansion of the nervous centres, is entirely absent; being represented by a simple extension of the spinal cord, which runs out to a blunt point. The absence of brain and of heart sufficiently distinguishes *Branchiostoma* from all other fishes. Its aspect, in fact, is hardly that of a fish at all, being highly vermiform in appearance. The species hitherto described are all from European or North African waters.

Myxinoidei. The *Myxinoids* are hardly more fish-like in their appearance than the *Branchiostoma*, having been classed, by Linnæus and other writers, among the worms. The vertebral column, as in *Branchiostoma*, exhibits the persistence of the usually temporary chorda-dorsalis. The mouth is terminal, nearly circular, and provided with a powerful hooked tooth on the palate, with others in the tentaculated mouth. The lateral fins are entirely absent, as in the other *Dermopteri*. The species of this family, though small in size, are formidable from the manner in which they attack their prey, which consists of larger fish. *Myxine glutinosa*, a European form, is most generally found embedded in the bodies of other fish, as the cod, haddock, and others. The manner of its entrance is not exactly known; probably, however, by a perforation made by the mouth, assisted by the powerful hook. No species of this family are found in North America.

Petromyzontidæ. This family, the last of the *Dermopteri*, is also without lateral fins: a continuous median fin is formed by the coalescence of the dorsal, caudal, and anal. Respiration is generally performed by means of fixed gills, the lateral openings to which are seven in number on each side. A single nostril is placed on the top of the head. The principal forms belong to the genera *Petromyzon* or true lamprey eel, and *Ammocœtes*, or sand lamprey. The former have a circular mouth provided with numerous teeth, and fringed with ciliæ to assist the animal in attaching itself to the bodies of its prey. The mouth is a true sucker, adhesion being effected by atmospheric pressure. Fishes of various kinds are not unfrequently caught bearing the bloody circular scar produced by the bite of the lamprey, and quite often the lamprey itself. The catfish, or *Pimelodus*, appears to be especially liable to such attacks. The lampreys attain to great size, and

are highly prized by some nations. The love borne them by the ancient Romans is a matter of classical history, and at the present day they are favorite food of epicures. A prominent European species is the *Petromyzon fluviatilis,* shown in *pl.* 81, *fig.* 28. The *Petromyzon americanus* is the largest and best known American species. The genus *Ammocœtes,* with the general characters of the lampreys, differs mainly in the form of the mouth. This, instead of being continuous and suctorial, is composed of a circular projecting upper lip, the lower being transverse. The opening of the throat is guarded by a fringe of ciliæ. This genus is extensively distributed over North America, where several species are known. They accumulate in vast numbers in certain sand or mud flats, as those of the Susquehanna river, whence they are dug from a depth of four or five inches below the level of the water, to serve as bait for other fishes.

The Symbranchidæ are anguilliform fishes, distinguished from their allies by the greater or less union of both branchial apertures into one. The fins also are variously suppressed, some being without pectorals, and others without either these or vertical fins. The next family,

The Murænidæ or eels, with the normal structure of the gill apertures, yet have them very small and capable of being completely closed. The body is serpentiform, and although provided with scales, these are scarcely apparent, being embedded in a thick mucous skin. The air-bladder is polymorphous, and the intestines without cœca. The eels, in their different species, are inhabitants of both fresh and salt waters; those living in the former belonging generally to the restricted genus *Anguilla.* Species of Anguilla occur in greater or less number throughout the United States, being, however, very rare in many if not most of the waters of the Mississippi basin. Popular opinion assigns to these species a viviparous reproduction, owing to the apparent absence of individuals containing eggs. The ova are yet, probably, present in a due proportion of the supposed males, escaping observation by their diminutive size. The eel hardly yields to any other fish in the power of sustaining a deprivation of its proper element for a considerable length of time. To transport these animals over a considerable space, all that is necessary is to pack them in damp grass or some similar substance. They even leave the water spontaneously at night in search of food, or of a body of water better suited to their convenience than the one in which they may happen to be placed. Eels are said to be very susceptible to magnetic or galvanic influence: the simple contact of a knife being sufficient to paralyse them. When a magnet is presented to the dish in which the living animal may happen to be, violent contortions, a painful gasping after breath, and other signs of inconvenience, are reported to be exhibited. *Pl.* 82, *fig.* 5, is a figure of *Anguilla vulgaris.*

The Gymnotidæ, highly interesting on account of their electrical properties, are characterized by the anterior position of the anus, the entire absence of dorsal fin, the extent of the anal, and the position of the gill-opening. The best known species, *Gymnotus electricus* or electric eel, is a native of the tropical portions of South America. It attains to a great size, being sometimes over six feet in length, and almost a full load for a

strong man to carry. The electric or galvanic apparatus consists of four longitudinal bundles, disposed in two pairs, one larger above, and a smaller below, against the base of the anal fin. The fasciculi are divided by longitudinal partitions into hexagonal prisms, and transverse divisions separate these into small cells. The cells are filled with a gelatinous matter, and the whole apparatus is abundantly supplied with nerves from the spinal marrow. In the Torpedo, these nerves come directly from the brain.

The amount of electricity furnished by the Gymnotus is enormous. Faraday made a calculation in regard to a specimen of ordinary size examined by him, that a single medium discharge was equal to that from a battery of 3500 square inches charged to its maximum. It need not then be a matter of surprise that the Gymnotus is capable of killing a horse by repeated discharges; which it does by applying its whole length along the belly of the animal when in the water. The method of capturing the Gymnotus made use of by the South American Indians, consists in driving a number of horses and other cattle into the muddy pools in which the electric eels abound. Roused from their retreats in the mud, the Gymnoti emerge into the water, and gliding in among the animals, give to them violent shocks. A succession of discharges results in weakening the eels to such a degree, as to make it a matter of little danger or difficulty to capture them. The Voltaic pile, formed by the electric apparatus of the Gymnotus, is much like that of the Torpedo; the column being longitudinal, however, in the natural position of the animal, instead of vertical. The anterior or cephalic extremity is positive; the caudal negative; and the animal is capable of discharging any portion of its column. The substance occupying the cells is a dense albuminous liquid, with a small amount of common salt. Each cell is separate and independent, answering to the cell of the galvanic battery. This electrical power is not confined to the Gymnotus. Various species of Torpedo, one of which is found on the coast of Massachusetts, exhibit the same property in a high degree. Other electrical fishes are *Malapterurus electricus*, *Trichiurus electricus*, and *Tetraodon electricus*. Some insects, too, as *Redivivus serratus* and *Mantis electricus*, are reported to give electric shocks. It may be proper to mention, in conclusion, that the electricity of the Torpedo and Gymnotus is capable of exhibiting all the effects of ordinary electricity, and is in most cases entirely at the command of the animal, whether to emit or withhold it.

Clupeidæ. The fishes of this family exhibit considerable analogies to the *Salmonoids*, differing, however, in the absence of an adipose dorsal. Both maxillaries and intermaxillaries are employed in forming the margin of the upper jaw, instead of the usual introduction of the latter alone. The body is well scaled, the scales sometimes very large. Bones of the mouth variously provided with teeth, these occurring sometimes on the pectinated tongue.

The fishes of this family are among the most useful and indispensable to man. It includes the anchovy, the sardine, the sprat, the various herrings, and the shad. The Anchovy, *Engraulis encrasicholus* (*pl.* 81, *fig.* 3), is a small fish, a few inches in length, distributed throughout Europe, and

especially abundant in various parts of the Mediterranean. It is distinguished, as a genus, by the projecting and pointed upper jaw, and the long anal. The top of the head and back is blue; irids, sides, and belly, silvery white. This fish was well known to the ancient Greeks and Romans, who prepared from it a sauce called *garum*, held in great favor. They are taken in countless numbers on the coast of Sardinia, 400,000 having been caught at a single haul. The fishing is highly successful by night, when the anchovies are readily attracted by the glare of fire-pans. In preparing them for purposes of commerce the head and viscera must be removed; the former being bitter, and for this reason called *Encrassicholus* by Aristotle. The anchovies, after being washed clean, are placed with the belly upwards in vessels, a layer of fish alternating with one of salt, until the whole is full. Pressure must be exerted to drive out the oil as much as possible. A hole is left in the top of the vessel, which is then exposed to the sun. After fermentation has commenced, the hole is stopped up, and the vessel removed to a store-house. The operation is not completed until the following year. The anchovy is taken from December to May.

The *Clupeidæ*, with non-projecting upper jaws, are divided into various genera, as *Clupea*, *Sardinella*, *Harengula*, *Pellona*, *Meletta*, *Alosa*, and others. A distinction was formerly made between a genus *Alosa*, characterized by an emargination of the upper jaw, and *Clupea*, with the border of the jaw continuous or entire. This division, however, has been found to be inadequate to the wants of the present system.

Alosa vulgaris, a European species, figured in *pl.* 81, *fig.* 1, is represented in America by one of much finer flavor, the *A. sapidissima*, or common American shad. This well known species commences its entrance into our rivers, at periods varying from January to May, according to the latitude. It penetrates all the Atlantic streams, and when unobstructed by dams or other impediments, travels to a considerable distance from the mouth for the purpose of depositing its spawn. They are taken in great numbers, especially in Chesapeake and Delaware bays, by various means, the most conspicuous of which are large seines and gill nets. The price varies from five to fifty dollars per hundred, according to the abundance or size. As already remarked, various herrings occur in immense numbers. Conspicuous among European species, in this respect, is the sprat, *Harengula sprattus* (*pl.* 81, *fig.* 4); but vastly more so the common herring, *Clupea harengus* (*pl.* 81, *fig.* 2). The true abode of the immense hordes of herring is not, even at this day, definitely ascertained, the fish being scarcely known, except in its wanderings. Some naturalists suppose it to come from the high north to deposit its spawn upon the shores of the North Sea; others, again, consider the bottom of the North Sea to be its home, since it is first visible at the Shetland Islands in April. Here myriads of herrings combine into armies many miles in length, and then pass on to the coasts of Norway, England, Germany, and the Netherlands. From the main army, branches go off in various directions, supplying almost the whole coast of Europe, and possibly extend their migrations even to the northern coast of North

America. They have never been seen to return to the north, and their migrations themselves occur neither at perfectly regular intervals nor in the same direction. The density of the columns also varies much in different parts of the army. In some seasons the numbers are countless, in others very limited ; at one time the individuals will be fat and large, at another very lean. By the end of August they are no longer seen. The Dutch, who, since 1164, have prosecuted the herring fishery with the greatest success, sometimes employ whole fleets of boats in the pursuit. At no very remote period, the number of boats annually leaving the Texel, under the protection of vessels of war, amounted to not less than eleven or twelve hundred. This trade was at its highest state of prosperity in the year 1618, at which time the number of boats employed was 3000, manned by fifty to sixty thousand men. Since that time the trade has passed out of the hands of the Dutch, to a certain extent, and is carried on by many nations of northern Europe. According to Black, the fishermen of Gothenburg alone, in his time, took upwards of 700,000,000 herrings. More than 130,000 barrels have been exported from Bergen in Norway ; the amount consumed in the entire land exceeding double this number. At the present day, the largest quantities are taken on the shores of England. Recent investigations have rendered it probable that the herring actually does live within a moderate distance of the localities where it is caught, coming in from the deep water for the sake of depositing its spawn.

A beautiful spectacle is exhibited when the herring approach the shores ; the rays of the sun are reflected from myriads of silver scales, and above the army may be seen hovering hosts of gulls, terns, and other sea birds. Behind and alongside are numerous rapacious fish, which, with seals, porpoises, and other marine animals, devour immense numbers. The water is filled with loose scales, rubbed off by their close proximity. On account of their vast numbers, these fish are very easily captured. This is done by means of nets, either on shore or at sea. Every Dutch smack has four smaller boats along with it, to carry fresh fish to the sea ports, and for other purposes. They use nets of 500 or 600 fathoms in length, made of coarse Persian silk, as being stronger than hemp. These are blackened by smoke, in order that the fish may not be frightened by the white thread. The nets are set in the evening, buoyed by empty barrels, and stretched by weights ; they thus rest at the surface of the sea. In the morning they are drawn in by means of a windlass. The herrings are sometimes attracted within reach of the nets by lanterns suspended at various intervals. But a faint idea can be formed of the actual number of these prolific fishes, which exists at one time in the ocean. When we remember, however, that an annual consumption of over two thousand millions in Europe, not to mention the myriads devoured by fishes, birds, and various marine vertebrata, scarcely appears to affect their number, we may obtain an approximate conception of what that number must be to which the sum of those annually destroyed is in such small proportion.

As the herrings are so abundant, and the flesh at the same time so excellent, various modes have been adopted to preserve them for a certain length

of time. Even at sea many are salted down, and sold in this state. This is called by the French *saler en vrac.* To keep them longer than is permitted by this method, two other ways are made use of: they are called white-salting and red-salting (*saler en blanc* and *saurer*). To white-salt herring, they are gutted on being caught, and packed in barrels, with a thick brine poured over them. They are there retained, until it is convenient to give them a final packing. After the bustle of the fishing is over, the smacks or busses run in and discharge their cargoes, when the barrels are inspected, and the fish sorted under the inspection of official authorities. They are then repacked with fresh lime and salt, and the particular quality marked on the barrel by the brand of an inspector. The red-salting is effected by allowing fat herrings to lie for a considerable time in the brine, then arranging them on hurdles, and placing them in ovens holding from ten to twelve thousand, for the purpose of being dried and smoked. The invention of pickling, as applied to herring, has been ascribed to Wilhelm Böekelson, or Beukelson, a fisherman of Viervliet in the province of Zealand (about 1440): he, however, only improved an art known before his time. The Emperor Charles V. eat a herring over his grave, in thankful acknowledgment of his worth, and erected a monument to his honor in 1556.

Several species of herring are caught in vast numbers on the coast and in the Atlantic rivers of the United States. The principal of these is the *Clupea elongata*, the representative of *C. harengus*. Besides *Alosa sapidissima*, or shad, already mentioned, *Alosa tyrannus* and *A. menhaden* are of economical value, the former as an article of food, the latter for manure. Immense numbers are taken and spread on poor lands, to which they impart a fertility not inferior to that produced by guano.

Salmonidæ. The *Salmonidæ*, or trout family, agree with the *Clupeidæ* in the structure of the upper jaw, and are most prominently distinguished by the presence of an adipose dorsal, a small fatty fin behind the true dorsal, near the tail. The intestinal canal is provided with numerous cœca. The scales are more or less conspicuous. All the bones of the mouth are furnished with teeth, as is also the tongue. The branchiostegal rays are about ten in number.

The entire family is eminent for delicacy of flesh, and for the possession of those game qualities so dear to the angler. Species are spread over the more northern regions of America, Europe, and Asia; although the number of such is greater in North America than anywhere else. The principal genera are: *Salmo*, *Thymallus*, *Osmerus*, *Mallotus*, and *Coregonus*. Conspicuous among the species of *Salmo*, is *S. salar*, or the true salmon, found on the northern shores of both Europe and America. It attains to a great size, an individual of 81lbs. having been taken in England. The largest American specimens do not exceed 50lbs., the usual weight being considerably less. Salmon were formerly caught in large numbers in the Connecticut river, but at the present day few are taken south of the Kennebec river in Maine. *Pl.* 82, *fig.* 7, represents *Salmo fario*, a species very abundant in Europe, especially in England. Its maximum size is about 25lbs., although a weight of a few pounds is nearer the average standard.

Its nearest representative in the United States is the *Salmo fontinalis* or common brook trout, occurring from Maine to the southern parts of Virginia, and perhaps below this in the mountainous regions. It does not attain a great size in running streams, a weight of four pounds being considered enormous. In small lakes, however, it is found much larger than this, being sometimes mistaken for the *Mackinaw* or great lake trout, *Salmo amethystus* of Mitchell. This most gigantic of all *Salmonidæ* inhabits the great lakes of North America, and is especially abundant about Lake Huron. Individuals of 35lbs. weight are of no great rarity, although 15 is perhaps the average. Dr. Mitchell records one weighing 120lbs., but at the present day they seldom exceed 80. *Salmo confinis*, a less gigantic species, inhabits the smaller lakes of the northern United States: *S. siskewit* is a native of Lake Superior, and numerous species are found represented in the waters of Arctic America. The genus *Thymallus* or greyling, represented in Arctic America by *T. vexillifer*, is distinguished from the true Salmo by the larger scales and the elongated dorsal. The European greyling is *T. vulgaris*. *Mallotus villosus*, or the capelin, is found on the coast of Labrador and Newfoundland, where it is used as a bait for the cod. It is sometimes found in a fossil state, in diluvial formations, on the eastern coast of the United States, as in New Hampshire. The genus *Osmerus*, or smelt, is represented by *O. viridescens*. It is known in some portions of the country as the frost fish, and is exceedingly abundant in the northern United States. In the winter season it congregates in large numbers in Lake Champlain, and may be taken with great ease through holes cut in the ice. *Coregonus* is another genus of the *Salmonidæ*, famed for the excellence of its flesh. The celebrated "white fish" of the lakes is included under several species of *Coregonus*. A species, *C. otsego*, from the small lakes of New York, is known as the Otsego bass. Additional species occur in the regions north of the United States. Species of this same genus are abundantly distributed over northern Europe.

Scopelidæ. Fishes of this family have the upper jaw formed entirely by the intermaxillaries. The branchiostegous rays are ten to fifteen in number. Mouth deeply cleft. A second adipose dorsal. The species are mostly marine, one occurring, however, in the Lake of Mexico, *Saurus mexicanus*. Another genus remarkable for its extreme beauty and diminutive size is *Scopelus*.

The Characini are salmonoid fish with a posterior adipose dorsal, and only six or seven branchiostegal rays. The divided air-bladder and tympanic ossicles ally them to the *Cyprinidæ*. The intestine has numerous cœca, and the superior maxillary enters considerably into the composition of the mouth. Many of them are highly ferocious, and characterize the rivers of South America, where they are sometimes dangerous even to man. The only exceptions to this distribution are to be found in the genus *Percopsis* of North America, one species of which is found in Lake Superior, another in Lake Champlain, and a third in the Alleghany river. They are highly interesting on account of their palæontological relations as well as their structure, which combines a ctenoid scale, with a general

cycloid structure. These have recently been placed by Prof. Agassiz in a new family, *Percopsidæ*.*

Galaxidæ. This family, containing but few forms, exhibits characters intermediate between the *Salmonoids* and the *Esocidæ*. With a structure somewhat similar to some of the former, it has the dorsal far back, and the intestinal character of the latter. The upper jaw is formed partly by a short intermaxillary, partly by the maxillary. The mouth presents much of the cyprinoid structure. The species are mostly oriental.

Esocidæ. In the *Esocidæ* the body is elongated, the single dorsal placed far back, and opposite the anal. The upper jaw is constituted by the intermaxillaries, almost entirely; the maxillaries when they enter as an element are destitute of teeth. Intestines without cœca. Teeth generally well developed in various parts of the large mouth. Branchiostegous rays from three to eighteen.

The genus *Esox* is characterized by the broad depressed head and mouth; the latter with teeth on the tongue, vomer, palatines, and branchial arches. The jaws have long, sharp, compressed teeth. The *Esoces*, or pikes, are among the most formidable of all fresh-water fish. By reason of their slender elongated form, they are able to live in shallow waters; penetrating, even when of considerable size, into very small brooks. Tyrants of the fresh water, no fish can compete with them except the trout; and it is very seldom that both forms are found in the same waters. Of two branches of the same stream, one may be peopled by the former, and the other by the latter. The only species of pike found in Europe is the *Esox lucius*, shown in *pl.* 82, *fig.* 3. It is found in all the principal fresh waters of Europe; where, there is reason to suppose, they are much more abundant at the present time than formerly. This species attains to a weight of 70lbs., although individuals of this size are of rare occurrence. North America is especially rich in species of pike: those inhabiting the northern lakes, as the *Maskalonge*, *Esox nobilior*, *Esox estor*, and others, attain a great size. Specimens of the former have been known of over 70lbs. The more southern species, as *Esox clathratus*, and others, are of more moderate dimensions. The American species may all be referred to two types, one with the opercula entirely scaled, and with fasciated or reticulated darker markings, with a vertical bar under the eye; the other with the lower half of the operculum free from scales, and the marks in the form of light spots on a dark ground.

Mormyridæ. This family contains fish characterized by an elongated body provided with oblong scales. The entire head, not excepting the cheeks and operculum, covered by a thick skin completely concealing the bones of the head. This is drawn over the operculum, in such a manner as only to leave a vertical narrow slit in each side: this skin is perforated by a number of pores. Mouth, with the tongue, well armed with teeth. Two cœcal appendages. The fishes of this family are almost all inhabitants of Africa.

* Since the above paragraph was written it has been ascertained by Prof. Agassiz that the genus *Percopsis*, with *Corniger* (from Brazil) must constitute a distinct order of fishes. It is likewise possible that the three species referred to are really one.

Hypsæidæ. This highly remarkable family is established on a single species, the *Amblyopsis spelaens*, or blind fish of the Mammoth Cave of Kentucky. It is characterized by a form much like that of a *Hydrargira*, to which it would at first be referred. The head, however, is much depressed, and the eyes are entirely wanting, none being evident even on dissection. The body is covered with scales, and the jaws provided with fine teeth. The intestinal canal is shorter than the body. Cœcal appendages two, pyriform, and opening by distinct orifices in each side of the intestine. Air-bladder heart-shaped, deeply cleft anteriorly. The anus is situated anterior to the base of the pectorals. The fins are provided with filamentous tips.

This very curious fish combines the characters of the *Esocidæ*, *Salmonidæ*, and *Cyprinodontidæ*, although its affinities are most with the latter. Like these, too, it is ovo-viviparous, the young being from ten to twenty in number. The color is a dull white. The animal is caught in a stream of water flowing across the Mammoth Cave, in which it is readily seen by the contrast of its white sides with the darker body of the water. A species of *Astacus*, *A. pellucidus*, likewise white and destitute of eyes, inhabits the same water in great quantity.

Cyprinodontidæ. The species of this family, which experiences its greatest development in America, are generally of small size. In fact a certain species found in South Carolina is not much over half an inch in length, even when comparatively large, and the others are not of much greater magnitude. Most are inhabitants of brackish water, although all the fresh waters of North America have their representatives. Body variously shaped, generally elongated and sub-depressed, especially anteriorly. The fins are all rounded, and the dorsal is situated far back, above the anal. The jaws are provided with small teeth which are sometimes denticulated. Hooked teeth on the pharyngeals. Air-bladder single. The principal genera are: *Fundulus*, *Lebias*, *Mollinesia*, *Hydrargira*, and *Cyprinodon*. Some of these are remarkably tenacious of life. Species of *Hydrargira* have resisted the influence of the air-pump vacuum, under circumstances where the same deprivation of air would have killed almost any other fish. This genus can live for months buried in soft mud, after their native pond dries up, coming out again on the accession of fresh water

Cyprinidæ. We come now to the consideration of the family of the *Cyprinidæ*, which embraces by far the greater number of the exclusive residents of fresh waters. Every variety of size and shape occurs; the flesh, however, of but few, is worth much as an article of food. They are distributed over all the temperate and cooler waters of the globe, their occurrence in tropical waters being very limited. The family is characterized by the absence of teeth in the mouth, and the development of teeth of various kinds and shapes upon the posterior branchial arch, or pharyngeal bone. The shape and number of these teeth furnish excellent generic characters. The former are exceedingly varied, each region having some peculiar to it: as *Schizothorax* for Syria, *Catastomus* and *Exoglossum* for North America, &c. A prominent European form is *Chondrostoma nasus* (*pl.* 84, *fig.* 4). *Alburnus lucidus*, or the bleak, represented in *pl.* 84, *fig.*

7, is another; the silvery pigment lining whose scales is used in the manufacture of artificial pearls. *Tinca vulgaris* (*pl.* 84, *fig.* 12) sometimes attains a considerable size. *Gobio fluviatilis* (*fig.* 6) is likewise extensively distributed. *Barbus vulgaris* (*pl.* 84, *fig.* 10), or the barbel, a fish of some reputation among anglers, has been known to attain a weight of 15½lbs. *Cyprinus auratus*, or the common gold fish (*pl.* 85, *fig.* 12), is pre-eminently conspicuous among fresh-water fish for the beauty of the colors. The young fish is of a brown color, in which, after a time, there appear silver specks, which increase until the entire fish becomes silvery white. In this state it is known as the silver fish. Subsequently it gradually assumes a golden red color. The true home of this fish, called kin-yu in China, appears to be a lake near Tschang-Hon in the province of The-Kiang, whence it was carried to the different waters of China and Japan, and subsequently to Europe. It is generally kept in glass globes, or small vessels, in the house, care being taken to provide an abundance of fresh water every day. The gold fish are easily kept in fish ponds, where they multiply rapidly. In the cisterns or tanks used to contain the water for condensing the steam of steam-engines, they thrive remarkably well, owing to the amount of greasy matter floating on the surface; even though the temperature of the water reaches 100° F. and upwards. The river Schuylkill, near Philadelphia, is well stocked with gold fish, from individuals which escaped from certain fish ponds near that city. They also occur in the Hudson River.

When kept in globes, the gold fish devour insects, worms, bread, fat earth, &c., with avidity at certain times, although they totally refuse all food at others. They eat pieces of cracker with great greediness; care, however, should be taken, not to give them more than they can consume at the time, as any portion uneaten, when dissolved in the water, affects its respiratory properties. In confinement, the form is apt to vary considerably, certain monstrosities, as three or four tails, being sometimes produced. These fish spawn in May, and if not watched will eat their own eggs. This should be prevented by removing the latter to a separate vessel, and exposing to the sun. The flesh is very pleasantly flavored.

Another species, *Cyprinus carpio* (a variety of which, *Cyprinus rex cyprinorum*, is shown in *pl.* 84, *fig.* 11), is found abundantly throughout Europe, where it is highly prized as an article of food. For this purpose it is kept in preserves and ponds, where it attains to a large size. Individuals of eighteen pounds' weight have occasionally been caught. Like the gold fish, this carp has been naturalized in North America, especially in the Hudson River, where it abounds, and is protected by legislative enactment.

North America abounds in species of *Cyprinidæ*, many of which are yet undescribed. With species belonging to some of the genera above-mentioned, as *Alburnus*, *Gobio*, &c., there are many of genera peculiar to herself. No true *Cyprinus* is, however, found, nor perhaps *Barbus*, although there are many species with the barbels characteristic of these genera. Closely allied to *Leuciscus*, in size and general structure, but differing in the possession of barbels, is the genus *Chilonemus*, one species of which, *C.*

cataractus, or the fall fish of Pennsylvania, attains to a considerable size, perhaps larger than that of any other allied form in this country ; specimens have been seen nearly two feet in length, and weighing several pounds. This size is, however, exceeded by many of the European species. The peculiar genus *Exoglossum* is characterized by a trilobed lower jaw, the middle lobe formed by the extremity of the lower jaw, the lateral by cartilaginous expansions. Another interesting sub-family, embracing several genera and many species, is that of the *Suckers*, or *Catastomi*, known by the highly fleshy lips, which can be applied to any object like a sucker. The pharyngeal teeth are columnar or prismatic, not hooked and truncated. They are found abundantly throughout North America ; and different species are known by the various names of carp, sucker, mullet, buffalo-fish, red-horse, &c. *Pl.* 81, *figs.* 6, 7, represent *Cobitis fossilis* and *E. barbatula*, European species of a form not found in North America.

The concluding family of the order *Malacopteri*, or *Physostomi*, is found in the Siluridæ, represented in North America by the catfish. Fishes of this family have the skin either naked, and covered with a slimy secretion, or provided with osseous plates of various number and shape. The head is usually depressed, and provided with a variable number of barbels. In most, there is a second and adipose dorsal, sometimes confluent with the caudal. The first rays of the dorsal and pectoral fins are generally enlarged into strong spines; and the pectoral spine is capable of being inflexibly fixed, by peculiar mechanism, in a direction perpendicular to the axis of the body. The edge of the mouth is formed by the intermaxillaries suspended from the sides of the ethmoid, which enters into the outline of the mouth, forming the superior median portion. The sub-operculum is absent in the whole family.

Species of this polymorphous family are found distributed throughout the globe. In Europe, however, there is found but one species, the *Silurus glanis*, or sheat fish. This species, interesting from the fact of its being the largest fresh-water fish in Europe, the sturgeons excepted, is most abundant in central Europe, its existence in England being hypothetical. The weight has been known to exceed 100lbs., in this respect equalling some of the American *Siluridæ*. It differs from the North American species in the absence of a posterior adipose dorsal, in the very small true dorsal, and in the very long anal. Other species of this restricted genus, *Silurus*, are found in various parts of Asia, and perhaps Africa, but not in America. The American forms are highly varied, those of the northern continent, however, being quite uniform in structure. The two most conspicuous fresh-water genera are *Pimelodus* and *Noturus ;* the former with a distinct adipose dorsal, the latter with this dorsal confluent with the caudal. Numerous species of *Pimelodus* (cat-fish, horned-pout, bull-head) occur in the various waters of North America, some of which acquire a large size. One species, from the Mississippi, has been known to weigh over 100lbs. The flesh of many species is highly prized, owing to its sweetness and freedom from bones. The genus *Noturus*, known provincially as stone cat-fish, embraces but few species, found in the Atlantic streams south of

New York, and in those of the Mississippi valley. They will probably be discovered in the eastern rivers (in the Hudson at least), when their ichthyology has been more fully studied. Marine forms are met with in *Galeichthys*, *Arius*, and *Bagrus*, the former characterized by the high dorsal and pectorals.

South America exhibits some *Siluroids* of especial interest. Conspicuous among these are *Arges cyclopum*, or *Pimelodus cyclopum* of Humboldt, and *Brontes prenadilla*, which inhabit the highest regions in which fish are known to live. They are found in Quito, at elevations of more than 16,000 feet above the level of the sea, living in the streams running down the sides of Cotopaxi and Tungaragua. The most interesting fact in the history of these fishes is, that they are frequently ejected from the craters of the above-mentioned volcanoes, in immense numbers; the supply being probably derived from the subterranean lakes in the body of the mountains. Our space will not permit us to mention any other members of this interesting family, excepting the *Malapterus electricus*, the *Silurus electricus* of older authors. This species is characterized generically by the absence of the first dorsal, the adipose dorsal alone existing, as also by the possession of an electric apparatus or battery, somewhat intermediate in character between those of *Gymnotus* and *Torpedo*, although of much finer texture. The whole body beneath the integuments is inclosed by the apparatus in two layers of great compactness, and at first sight suggesting a deposit of fat. A dense fascia separates the battery from the muscular system. The cells, formed by transverse and longitudinal fibrous partitions, are rhombic in shape, and exceedingly minute. The nerves of the outer organ come from branches of the fifth pair of nerves, the inner organ is supplied by the intercostal nerves. The direction of the current is probably from the head to the tail; the cephalic extremity being positive, and the caudal negative.

We now come to the third order, *Pharyngognathi*, of our classification, divided into two sub-orders, *Malacopterygii*, or soft finned forms, and *Acanthopterygii*, or spiny finned. The only family belonging to the first division is that of the

Scomberesocidæ, characterized by a structure intermediate between that of *Esocidæ* and *Scombridæ*. The body is greatly elongated, and the jaws produced into long, very narrow beaks. The scales are minute, and hardly apparent in some species. The more conspicuous genera are *Belone* and *Scomberesox*; the former having a considerable external resemblance to the gar-fish, *Lepidosteus*, but with very minute soft scales, the latter having the posterior portion of the anal and dorsal divided into finlets, as in the mackerel, in other respects like *Belone*. This last mentioned fish is represented by several species in North America, one of which, *B. truncata*, occasionally penetrates the Atlantic rivers, as the Delaware and Susquehanna, and is known also as the silver-gar, or bill-fish. Neither genus is of any economical value. Inconspicuous in this respect, also, are the families Chromidæ, Cyclo-Labridæ, and Cteno-Labridæ, sufficiently characterized by the spurious fin rays, and the ordinal characteristics. The old family of *Labridæ*, including the two latter sub-divisions, which differ

in the one having cycloid scales, the other ctenoid, has a single dorsal supported in front by spines, each of which has generally a membranous appendage. The jaws are provided with fleshy lips. There are three pharyngeals, the two upper attached to the cranium, the lower larger, all armed with teeth of various kinds. Intestinal canal, with cœca, rudimentary, or none. The most interesting American genera are *Ctenolabrus* and *Tautoga*. The former is represented by *C. cæruleus*, found along the Atlantic coast from New Jersey, north; and known by the fishermen by the various names of bergall, cunner, blue perch, and chogset. *Tautoga Americana*, tautog, or black-fish, is much esteemed for the table, and is caught along the more northern Atlantic coast.

The order *Anacanthini* contains fishes of great importance to mankind as articles of food. This is divided into two sub-orders, the first *Apodes*, without ventral fins, the second *Thoracici*, with the ventrals under the pectorals, and the pelvis suspended to the bones of the shoulder. The typical genus of the single family Ophidiidæ, included in the first sub-order, is *Ophidium*, having the dorsal, caudal, and anal, either united, or separated by a small interval. The ventrals are wanting. A small barbel at each angle of the jaw. The North American species, *O. marginatum* and *O. stigma*, are quite inconspicuous in every respect. The next two thoracic families, *Gadidæ* or codfish, and the *Pleuronectidæ* or flat-fish, embrace species standing in the very first rank in economical value.

The Gadidæ have an elongated body, covered with soft scales, these not extending on the head. Jaws, and front of vomer, with pointed irregular teeth of various size, and gills with seven rays. Dorsal fins, three, or less; anal two, or one: cœca numerous. Air-bladder large, frequently indentated. The genus *Morrhua*, or true cod, has three dorsal fins, two anal; pointed ventrals. A median barbel at the end of the lower jaw. The best known species of cod is the *Morrhua vulgaris* (*pl.* 85, *fig.* 1), found in the European seas as far south as Gibraltar, and in the American to Newfoundland. The codfish caught off the coast of the United States belong to another species, *M. americana*. *M. vulgaris* is found in immense numbers on the banks of Newfoundland, where they give employment, in fishing, to vessels of all nations. They are caught with hooks, or seines sunk to a considerable depth in the sea. On the banks of Newfoundland, the usual fishing season is during the months of May and June. They are preserved by simple green salting, or are salted and then dried. The maximum size of this species, of 60 to 70 lbs., is exceeded by that of *M. americana*, which has been known to weigh 107 lbs., according to Dr. Storer. A cod of fifty pounds is, however, considered to be very large. Various applications are made of the cod, other than as an article of food; the oil from the liver (known technically as *oleum jecori*), in particular, is considered to be a highly valuable medicinal agent, especially in cases of pulmonary consumption. The roe, also, is used as bait for various species of herrings, as anchovies, pilchards, &c. Another species, *M. æglefinus*, or haddock, common to Northern Europe and America, is distinguished from the cod proper, among other features, by the jet black lateral line. Inferior

to the cod as an article of food, it is yet very palatable, and sold at a cheap rate. They do not attain to the enormous size of the cod, although they are caught off the New England coast, and consumed in great numbers. Other American species are *M. minuta*, or power-cod, *M. pruinosa*, or tom-cod, and others.

The genus *Merlangus*, which comes next to *Morrhua*, is similar to it in other respects, but is without the filament on the chin. A prominent European species, the *Merlangus vulgaris*, or whiting, is shown in *pl.* 85, *fig.* 2. It is, as far as known, not an inhabitant of American waters, its place being supplied, among others, by *Merlangus carbonarius* and *M. purpurinus*, both found abundantly off the coast of New England, where they are indifferently called pollack. The genus *Merlucius*, or hake, has two dorsals, the first short, the second very long; a single very long anal, and no barbel to the chin. A species, *M. albidus*, occurs in moderate numbers off the coast of New England, and is generally termed whiting. The genus *Lota*, or ling, is an inhabitant of fresh waters, being found of several species in the great lakes, and various parts of the New England States, as well as north of these. It is characterized by the elongated body, swollen belly, two dorsal and one anal fin, and the barbel on the chin. The lings, or eel-pouts, are not favorites in the United States, although a European species, *Lota vulgaris*, or burbot, is much esteemed. It is represented in *pl.* 81, *fig.* 11. The genus *Brosmius* has but a single dorsal, extending the entire length of the back; a single barbel at the chin. The American species, *B. flavescens*, or cusk, is much esteemed as an article of food. The genus *Phycis* has two dorsals, one short, the posterior very long; the ventrals of two long rays united at the base. A single barbel on the chin. An American species, *Phycis americanus*, known as the hake or codling, is taken in considerable quantity, as an article of food. Other genera, as *Macrourus*, *Motella*, which occur in the American seas, are of little economical value.

The family of Pleuronectidæ, or Planidæ, of some systematic writers, exhibits a remarkable anomaly, in having both eyes placed on the same side of the head. The body is compressed and broad, with a single dorsal extending from the head to the tail. There is no air bladder, and the fishes of this family swim at the bottom of the water on one side, which is generally white. The occurrence of both eyes in either the right or left side may be either accidental or else a constant generic or specific character. Branchiostegous rays six. The genus *Platessa* has both the eyes and the color on the right or left side of the head; the body rhomboidal. A row of teeth in each jaw, and others in the pharyngeals. Dorsal fin commencing over the upper eye, and with the anal extending nearly the whole length of the body, but not joined to the tail. The genus is represented in America by seven or eight species of various character, the larger of which, known as flat-fish or flounders, furnish an excellent article of food. *Platessa flesus*, known in England as the flook or fluke, is figured in *pl.* 81, *fig.* 9. Another European species is *P. limanda*, or the dab. The genus *Hippoglossus* has a more elongated form, and stronger

and sharper teeth. In it is the species *H. vulgaris*, or halibut, found on the coasts of both Europe and America. It attains to a very large size, individuals of even 500 and 600lbs. having been met with. Its flesh is highly prized, and the fins are world-renowned as an epicurean morsel. In *Rhombus* both the eyes and color are on the left side: the dorsal commences anterior to the eye: dorsal and anal fins extend nearly to the tail. Teeth exist both in the jaw and pharynx. Conspicuous in this genus is *Rhombus maximus*, or the turbot, celebrated as the best of all European fishes. A turbot, probably of a different species, has recently been detected off the coast of Massachusetts. *Pl.* 81, *fig.* 8, represents *Rhombus vulgaris*, or the brill, a common European species. The genus *Achirus* is without pectoral fins, and has the eyes on the right side of the head. Mouth distorted to the side opposite the eyes, and very small. Dorsal and anal not united to the tail, as is the case in the genus *Plagusia*. The *Achirus mollis*, or common sole, is very abundant on the Atlantic coast of the United States. *Pl.* 82, *fig.* 11, represents the *Solea vulgaris*, European sole.

The family Echineidæ is represented by the genus *Echineis*, which comprehends fishes with a flattened disk upon the top of the head; this being composed of a variable number of cartilaginous plates, movable in such a manner as to admit of their being attached by suction to an object in the water. A single dorsal opposite the anal. Teeth on the jaws, vomer, and tongue. *Pl.* 84, *fig.* 3, represents the *Echineis remora*, or sucking-fish, found throughout the Atlantic ocean. There are additional species with various characters.

We come now to an order of fishes, *Acanthopteri*, corresponding nearly with, but rather more restricted than, *Acanthopterygii* of Cuvier. This order is characterized by the ctenoid scales, the advanced ventrals, the spinous fins, &c. It embraces many species of considerable value. The first family, Percidæ, is known by the rough scales, the dentated operculum or preoperculum, and the occurrence of teeth in the jaws, the front of the vomer, and generally on the palatines.

The number of genera and species in this family is very great, distributed as they are over the entire globe, and occupying both salt and fresh water. Two principal types may be distinguished, one with a single continuous dorsal, the other with this dorsal more or less deeply divided, and separated into two. The typical genus is that of *Perca*, with two separated dorsals, the rays of the first spinous, of the second flexible; teeth in both jaws, in front of the vomer, and on the palatines; tongue smooth; operculum with a short, flattened, backward spine. *Perca fluviatilis*, the most common European species, is figured in *pl.* 82, *fig.* 4. Numerous species occur in North America, the most conspicuous of which is the *Perca flavescens*, or common yellow perch, which is found in almost all sorts of situations, both salt-water and fresh. Several closely allied species occur in the different lakes and rivers of the North American continent. The genus, or rather subfamily, *Etheostoma*, is altogether peculiar to North America, where nearly every large river has one or more species peculiar to it. They are all of rather small size, some of them very minute. Professor Agassiz has recently

placed these fish amongst the *Cottoids*. The genus *Labrax* is allied to *Perca*, but has scales on the two-spined operculum, and teeth, or prickles, on the tongue. The most conspicuous species is the *Labrax lineatus*, the rock-fish, or striped-bass, of the United States, a fish of great excellence in the opinion of many persons, especially when taken in autumn. It is caught in the winter and spring along with the shad, and like it is an anadromous fish, running up from the salt-waters into the fresh streams for the purpose of spawning. It attains a size of 60 to 70lbs., although more usually weighing from 4 to 20lbs. Its European analogue is the *Labrax lupus*, or bass, shown in *pl.* 82, *fig.* 10, and highly esteemed as an article of food. Other species occur in the United States, as *L. mucronatus*, or the white perch of the eastern waters, *L. multilineatus*, and others. The genus *Lucioperca* combines the general characters of perca with teeth like those of the pike. Its most striking resemblance is, however, to the salmon, for which reason it generally bears this name in the rivers of the interior of America. *Lucioperca americana* is the most abundant species, and, as already mentioned, is usually called salmon, sometimes pike, as in Lake Champlain. It is a bold, voracious fish, of great strength, and affords excellent sport to the angler. An allied species is found in the rivers of central Europe. *Centropristis* has a single dorsal, and an oblique tail; preoperculum dentated, and operculum spinous; teeth small and crowded, no canines. A common American species, *C. nigricans*, known as sea-bass, or black perch, is much esteemed as an article of food. *Grystes* also has a single dorsal, and a considerable resemblance to Centropristis; having, however, the preoperculum entire, and the tail truncate. It occurs in various rivers of North America, and is represented by several species in the waters of the Mississippi and of the great lakes, as also in the waters of several streams having their outlets on the southern Atlantic coast. None have been found in the Potomac or Susquehanna; and those met with in the Hudson River have been introduced from Lake Champlain, through the Hudson and Champlain canal. They are generally known as black bass in the North; another species of a different color in the South, being improperly called trout and white salmon. They afford excellent sport to fishermen, ranking in point of "game" qualities above most other fresh-water species, after the Salmonidæ. Their flesh also is excellent eating. *Centrarchus* has an oval, compressed body, with two flattened spines to the operculum, six or more spines to the anal fin; a single dorsal; and velvet-like teeth in both jaws, on the vomer, palatines, and the base of the tongue. Several species inhabit the waters of the United States; one of these, *Centrarchus æneus*, rock-bass, or black sunfish, being found in the waters of the Mississippi, and in the great lakes. This species is also highly prized for the sport it affords in fishing. The genus *Pomotis* is distinguished from the preceding, mainly by the presence of an opercular, membranous flap, posterior to the flattened spines. The palatines and tongue are without teeth. Species of this genus are numerous, and generally distributed, in North America. They are known as sun-fish, pumpkin-seed, sun-perch, and bream.

Another genus of *Percoids*, *Holocentrum*, has brilliant and denticulated scales, a spinous and denticulated operculum, and a preoperculum, with a well developed spine, projecting posteriorly. A species, *H. longipinne* (*pl.* 83, *fig.* 1), is found in the American waters. The genus *Sphyræna* has a greatly elongated body, with two separated dorsals. Lower jaw longer than upper: both with strong teeth. Ventrals posterior to the pectorals. A species of this genus, *S. barracuda*, is found on the southern shores of the United States, particularly about the Florida reefs, where it is more dreaded for its ferocity than the shark. It is there called barracuda pike, or barracuda, and attains a length of six or seven feet. *Sphyræna spet*, a Mediterranean species, is figured in *pl.* 83, *fig.* 4. A species of *Trachinus*, *T. draco*, sea-cat, or weever (*pl.* 81, *fig.* 12), is much feared for the injuries it can inflict with its spinous dorsal. A special regulation in France requires that these spines be cut off before the fish is exposed to sale. It has not yet been found in American waters. *Acerina* constitutes a genus of fresh-water fish, allied to the true perches, but has a single dorsal fin. Of two species, both European, *A. cornua*, or the ruffe, is found in various waters of England and the continent. Its flesh is well esteemed, but the fish never attains to a large size. Figured in *pl.* 83, *fig.* 10. The genus *Mullus*, or mullet, has two separated dorsals, and two cirri at the symphysis of the lower jaw. The genus is not found in America. *Pl.* 85, *fig.* 7, represents *M. barbatus*.

The next family is that of the Sclerogenidæ, or Triglidæ, with the head spined and armed in various ways. The suborbital bone is extended more or less backwards, and articulated to the preoperculum. The genus *Trigla* has the operculum and shoulder-plate running out backwards in a spine; seven branchiostegous rays, and three detached rays at the base of each pectoral fin. *Trigla lyra*, or the piper (*pl.* 83, *fig.* 7), is a rather rare European species. *T. cuculus* occurs on the coast of the United States. More American species are found in the genus *Prionotus*, closely allied to *Trigla*. *Dactylopterus* has the detached filament of *Trigla* greatly elongated, so as to exceed in length the fish itself, and united by a fin by means of which it can be sustained in the air for a short period of time. The best known species is *D. volitans*, or flying-fish, and is shown in *pl.* 83, *fig.* 12. There is another flying-fish, *Exocœtus*, belonging to the *Esocidæ*, which is a better flyer than *Dactylopterus*. The genus *Cottus* has a variously-armed head, which is large and depressed; teeth in both jaws, and on the front of the vomer; branchiostegous rays six; two dorsals, distinct or but slightly connected, ventrals small. Two distinct types of this genus exist, one with the head strongly armed with spines of various kinds, and the other with the spines few in number, and nearly obsolete. The latter are all fresh water, the former marine. Numerous species of fresh water *Cottus* occur both in Europe and America, all closely resembling each other. They may be distinguished geographically by the fact, that while the small subcutaneous plates along the lateral line are continued out to the tail in the European species, in the American they cease within a short distance (one fourth, perhaps) of the total length, and

the lateral line extends to the tail only as a light furrow. *Pl.* 84, *fig.* 5, represents one of the European species of fresh water *Cottus*, known as the bullhead, miller's-thumb, chabot, &c. The salt water species are termed, provincially, sculpins or bull-heads. *Aspidophorus* has the body octagonal, and covered with scaly plates; snout with recurved spines; no teeth in the vomer; two dorsal fins. *A. cataphractus* (*pl.* 82, *fig.* 1) is found both in Europe and America. The genus *Scorpæna* resembles *Cottus*, but has a compressed head, an undivided dorsal, and palatine teeth; as also cutaneous filaments in various parts of the body. *S. scropha* is represented in *pl.* 83, *fig.* 5. Somewhat allied to *Scorpæna* is the genus *Synanceia*, a species of which, *S. horrida*, is shown in *pl.* 82, *fig.* 9. It is from the Indian seas. The genus *Sebastes* has some resemblance to the perch, but differs in the spined operculum and preoperculum. All parts of the head are covered with scales; branchiostegous rays seven; teeth on the jaws, vomer, and the palatines. *Sebastes norvegius*, Norway haddock, snapper, or rose fish, is a highly beautiful fish, of a reddish color, and is taken in deep water, off the coast of New England and further north. The genus *Gasterosteus*, or stickleback, closes the series of those *Triglidæ* which we have room to mention here. They have a body without scales, but variously armed with plates on the sides and back. A variable number of the anterior dorsal rays occur as separated spines. Ventral fins represented by a single spine. Branchiostegous rays three. The species of this genus are mostly of small size, and inhabitants of brackish water; yet some species occur in perfectly fresh water. They are highly quarrelsome, active little fish; and one European species, at least, is remarkable for constructing a regular nest of grass. The male performs this labor of love, and forces females successively into the nest, there to deposit their spawn, which he immediately fecundates. The nest and its contents are watched with the most jealous vigilance by the male stickleback, who exercises a careful guardianship over the young after they are hatched. Other species of *Gasterosteus* will probably be found to possess the same habit, shared also by some other genera, at least by *Callichthys* of South America. *Pl.* 82, *fig.* 6, represents the common European species, *Gasterosteus aculeatus*.

The third family, Sciænidæ, exhibits a close parallelism with the *Percoidæ*. The vomer and palatines are, however, destitute of teeth, and the head is generally enlarged by cavernous swellings. The ventral fins are sometimes scaled.

The first genus with an American representative is *Otolithus*, characterized by the two dorsals, the weak anal, the absence of barbels, and the two or three highly developed front teeth. The principal species is *O. regalis*, or weak fish, abundant on the whole Atlantic coast. It is called salt water trout, or simply trout on the southern coast. Another species is called salmon trout. When caught in the latter part of the summer, and eaten within a few hours after its capture, it is, perhaps, superior in delicacy of flavor to any salt water American species, excepting the far-famed sheepshead, and scarcely inferior even to this most delightful of fish. *Corvina* differs in the strong second anal spine and the perfectly

even, velvety teeth. Generally there is a series of larger, equal, and sharp teeth in the upper jaw. *Corvina oscula* is found in the interior waters of North America, where it is generally called "sheepshead." The flesh is of little value as an article of food. Its southern congener, the *C. ocellata,* or red fish, found abundantly in the Gulf of Mexico and about New Orleans, is much more highly prized in this respect. It bears various names, as bass, sea-bass, red bass, at different points along the Atlantic coast, and is occasionally caught as far north as Long Island Sound. *Leiostomus* has a feeble anal spine, with minute denticulations in the preoperculum. Teeth in the jaws equal, and very minute. Pharyngeals paved posteriorly; two dorsals. One species, *Leiostomus obliquus,* known as Lafayette, or crocus, or chub, is abundant along the middle Atlantic shores of America, and somewhat esteemed as an article of food. Another, *L. xanthurus,* is found along the coast of South Carolina, where it is called yellowtail, or yellow Jack. The genus *Umbrina* is distinguished from the other *Scienoids* by the presence of a cirrus under the symphysis of the lower jaw. *Umbrina nebulosa,* or the kingfish, is highly prized as an article of food, being considered by many the best fish afforded by the New York market. *U. alburnus* is a closely allied species, found along the southern coast of the United States, called whiting in South Carolina. The genus *Pogonias* differs from *Umbrina,* in having several barbules under the jaw. *Pogonias chromis* is the well known drum of the Atlantic coast, a fish of very large size and excellent flavor. *P. Fasciatus* is the young drum of fishermen.

The next family, the Sparidæ, has unarmed opercles, the head not cavernous, the palate without teeth, and the jaws not protractile. Branchial rays not exceeding six. The genus *Sargus* has cutting incisors in front of the jaws, somewhat like those of man; the molars rounded. The most important species is *Sargus ovis,* the well known sheepshead, a fish among the first, if not the very first, in America, in point of excellence. It is caught along the entire Atlantic and Gulf coast, and is occasionally found of extreme size. Sheepshead are exceedingly abundant about the Florida keys, but are there considered very inferior fish. The further north they are taken, the better the flavor. Other and smaller species also occur. The genus *Pagrus* has two rows of small rounded molars in each jaw. *Pagrus argyrops* is the porgee of the Atlantic, in some estimation for the table.

The family of Menidæ is similar to the *Sparidæ,* but has a highly protractile mouth, and occasionally teeth on the vomer, and denticulations on the preoperculum. There are no American species of any special interest in this family.

Nature has given to the next family of Labyrinthibranchiæ a remarkable provision, enabling it to leave the water, and travel to a considerable distance in search of food. The eels, we have shown, possess this power also, by reason of the smallness of their gill-openings, which can be closed up very firmly. In the *Labyrinthiforms* there is a highly vascular membrane, folded together in a number of laminæ, and occupying the upper part of the anterior branchial arches. This membrane is highly

vascular, and appears to serve as a respiratory organ in itself, and also to intercept and retain water for a considerable time, sufficient to keep the gills moist during the terrestrial journeys of the fish. An Indian species, *Anabas scandens*, or climbing perch (*pl.* 84, *fig.* 13), can spend some considerable time out of the water in search of food. It is even said to climb inclined trees hanging over the water, but this has been doubted. Several genera of this curious family are known; all, however, Asiatic or African. *Pl.* 85, *fig.* 6, represents *Ophiocephalus striatus*, an Indian form.

MUGILIDÆ. These have a nearly cylindrical body, with two distinct dorsal fins, the first with four spinous rays. Ventrals rather behind the pectorals; gills, six-rayed. Head depressed, covered with large scales or polygonal plates. Teeth very fine. The most conspicuous genus is *Mugil*, several species of which occur in the United States. *Mugil albula* or the common mullet, is caught in great abundance along the whole southern Atlantic coast of the United States; where, indeed, it forms a much esteemed article of food, although rather too fat and rich. The roe is considered to be an especial delicacy. These fish are caught in seines throughout the greater part of the year. The genus *Atherina* is composed of small fish, with very protractile mouth, elongated body, two dorsals far apart, the anterior spinous. A silvery band on the side, ventrals behind the pectorals. First branchial arch with bony pectinations. This genus is represented in North America by several species, mostly marine.

The passage to the true *Scombridæ*, or mackerel family, is made by the NOTACANTHIDÆ. The body is long, and supplied with small soft scales; snout obtuse, projecting beyond the mouth, which is furnished with fine close teeth. No true dorsal fin, but a series of free spines on the back, unconnected by a membrane. Free spines before the anal. *Notacanthus nasus* is found in the Greenland seas.

SCOMBRIDÆ. This family, in the economical value of its component species, yields to no others, the *Gadidæ* and *Clupeidæ* not excepted. It embraces the various mackerels, tunnies, dories, &c., together with many others, of less general distribution, but of great local abundance and excellence. The fishes of this family have small scales, so minute, indeed, as to cause the skin to appear smooth; the ventrals are without scales, the opercles without spines or denticulations, the caudal generally large and powerful, and the intestines mostly with numerous cœca.

At the head of the family stands the genus *Scomber*, or true mackerel, characterized by the fusiform elongated body, two small cutaneous crests on the sides of the tail; some of the posterior rays of the anal and second dorsal fins free, forming finlets; and one row of small conical teeth in the jaw. *Scomber vernalis*, or the common mackerel, is very abundant along the more northern coast of the United States. It is not usually caught in quantity before the beginning or middle of June, although obtained in greater or less number along the coast of Massachusetts throughout the year. This fish is exceedingly voracious, but capricious as voracious, sometimes biting with the greatest readiness, and at others entirely refusing the bait. The number and occurrence of mackerel in particular localities

are also very variable, in some seasons the returns hardly paying the expense of the expeditions. Some idea of the extent of the trade may be formed from the fact that, in a single year, upwards of 234,000 barrels were taken by Massachusetts fishermen alone. A closely allied, but smaller species, *S. grex*, or chub-mackerel, is distinguished by a dark spot at the tip of the lower jaw. *S. colias*, or the Spanish mackerel, is also much esteemed, but rarer than the two preceding. It is distinguished from *S. vernalis* by the fact that the transverse undulations do not cross the lateral line, as in the latter species. In *S. vernalis*, also, there is a dusky line beneath the lateral line, and a black spot at the base of the pectoral and ventral fins. *Scomber vulgaris*, or the common European mackerel, is represented in *pl.* 83, *fig.* 9. The genus *Thynnus*, or tunny, is distinguished from *Scomber* by the presence of a corselet round the thorax, formed by scales larger and coarser than those of the rest of the body. There is a bony and elevated crest on each side of the tail. The anterior dorsal reaches nearly to the posterior. Numerous finlets behind the dorsal and anal fins. A single row of small pointed teeth in each jaw. The common tunny, *Thynnus vulgaris*, is a mackerel of a gigantic size, and famed for the excellence of its flesh, which tastes something like lean pork. Fish of this species are caught in immense numbers in the Mediterranean, and eaten both fresh and salted. The usual method of preserving them for any length of time is to cut them into slices, which are packed away in barrels, with layers of salt interposed. They are generally caught in nets. This species is of rare occurrence out of the Mediterranean, where it is met with in great shoals. But few are recorded as being caught off the United States coast; one specimen, taken near Cape Anne, weighed 1000 lbs., and was fifteen feet in length. In New England it is known as horse mackerel and albicore. A European specimen is figured in *pl.* 83, *fig.* 8, A second species, of much smaller size, is found in the Gulf of Mexico. The bonito is also a species of *Thynnus* (*T. pelamys*), differing mainly in several large longitudinal stripes below the lateral line. It is this species, among others, which causes the flying-fish to leave the water in order to escape from its terrible enemy. The flesh is greatly inferior to that of the common tunny. The genus *Pelamys* differs from the last, in having strong separated and pointed teeth. The principal species, *P. sarda*, also called bonito, is of rare occurrence in American waters, where it is known as the skip-jack, especially in Massachusetts. *Cybium* is without a corselet, and has large compressed sharp teeth; the palatines with short and even teeth. One species, *C. maculatum*, or spotted mackerel, is of rare occurrence on the American coast. The genus *Xiphias*, or sword-fish, has a spindle-shaped body, covered with minute scales, a single elongated dorsal fin, ventrals wanting, upper jaw elongated, forming a sword-shaped protuberance; mouth without teeth. This curious genus, represented by *Xiphias gladius*, or the well known sword-fish (*pl.* 81, *fig.* 13), is generally distributed throughout the Atlantic, being found on both the European and American shores. It attains to a great size, being sometimes fifteen feet in length, and weighing many hundreds of pounds. The flesh, especially of the

smaller individuals, is highly esteemed, being considered equal to that of any of the mackerel family. Numerous instances are recorded of fish of this species having struck the snout through, or into, the timbers of a ship, mistaking it, as is supposed, for a whale, the sword-fish having, it is said, a great antipathy to this animal. It is highly destructive to other species, preying on the weaker mackerels to a great degree. The genus *Naucrates* has a single elongated dorsal, free spinous rays before the dorsal and anal fins; sides of the tail carinated; and numerous small teeth. The pilot-fish, *Naucrates ductor* (*pl.* 83, *fig.* 6), belongs to this genus. The pilot-fish, as is well known, possesses the curious propensity of following in the wake of large masses in the water, whether these be vessels or large marine animals. Instances have occurred of their following ships during a voyage of eighty or more days. Their attendance upon the shark has been supposed to be for the purpose of giving warning to their less vigilant or less acute companion, of the dangers to which it may be exposed. The interest, however, is probably, in both cases, that of protection against enemies and starvation. The genus *Coryphæna*, has a compressed elongated body, and a head with a globular outline; eyes low, near the angle of the mouth; dorsal fin rising from the cranium, and extending to the tail, diminishing in elevation posteriorly. This genus, including the fishes generally known as dolphins, and celebrated for their beauty, are mostly inhabitants of mid-ocean, being rarely found off the coasts. *Coryphæna hippuris* (*pl.* 84, *fig.* 2) is a well known companion of vessels, and greatly celebrated for the beautiful play of colors which it exhibits when dying. The dolphins are extremely voracious, and are conspicuous enemies of the flying-fish; it is also noted for the extreme velocity of its motions, a characteristic, however, of nearly all the *Scombridæ*. Several species occur off the American coast, where, however, *C. hippuris* has not yet been observed. The genus *Temnodon*, with the general port of a true mackerel, is more compressed, and has the second dorsal higher and longer than the anterior dorsal, and with the anal covered by small scales. The most striking characteristic lies in the possession of a single row, in each jaw, of large, distinct, compressed, and very sharp teeth, which give quite a formidable feature to the fish. The principal species is *T. saltator*, the blue-fish of the northern American waters, the tailor or skip-jack of those more southern. It is much esteemed both by the angler and the epicure. The genus *Zeus* has an oval compressed body, a protractile mouth, and the dorsal spines with long filaments, as the most striking characteristic. *Zeus faber* (*pl.* 81, *fig.* 10) is the well known dory, or John Dory, a European species much esteemed by epicures. It has a large round black spot on each side, ascribed by popular superstition to the marks of St. Peter's thumb, when he took the tribute money out of its mouth. In some parts of Europe it is called "king of the herrings," from the fact of its accompanying these fish for the purpose of feeding upon them.

The family of Squamipennes is readily known by the dorsal and anal fins, especially the soft portion, being covered with scales. The body is compressed, and more or less oval or rhomboidal. Teeth setigerous, or

like fine, close bristles, or cutting. Preoperculum occasionally spinous. Dorsals either two or one. The *Chætodons*, belonging to this family, are remarkable for their brilliant colors, the rhomboidal body, and the curious property possessed by the species, *Chelmon rostratus* and *Toxotes jaculator*, of ejecting drops of water, with unerring accuracy, at insects which may be within a moderate distance of the surface. In China and Java they are kept in vessels for the amusement afforded in watching the dexterity with which they will bring down flies at the distance of several feet. *Pl.* 84, *fig.* 9, represents a common species of *Chætodon, C. auriga.* A few species of *Chætodon* are found in America, especially in the Gulf of Mexico. The genus *Ephippus*, represented by two species, is found along the coast of the United States, where it is known as angel-fish, moon-fish, three-tailed sheepshead, &c. An American species of *Holocanthus, H. tricolor,* found in the Gulf of Mexico, is shown in *pl.* 82, *fig.* 8. Another genus, *Dipterodon*, contains a single species, *D. capensis* (*pl.* 85, *fig.* 8), from the Cape of Good Hope. The genus *Amphiprion*, a species of which, *A. bifasciatus*, is figured in *pl.* 85, *fig.* 9, is, perhaps, more properly referrible to the family of *Scienoids.*

The family of Tænioides is closely allied to the *Scombridæ*, under which head some authors include it; the principal distinction consists in the elongated flattened shape. The genus *Trichiurus* has the ventrals and caudal wanting; the dorsal extending all along the back, which runs out into a long slender filament. A few small spines represent the anal. The mouth is well armed and large, the jaw projecting. The general appearance of this genus is that of a bright silver ribbon; one species, *Trichiurus lepturus*, is occasionally caught off the coast of the United States. In the West Indies it is called sword-fish, and sometimes attains a length of twelve or fifteen feet. A remarkable genus, *Trachypterus*, has the body ending in a caudal appendage of varied shape, and a second caudal standing up vertically from the tail. The ventrals are more or less developed. *Pl.* 85, *fig.* 11, represents *Trachypterus spinolæ*, from the Mediterranean. *Cepola* has a long dorsal and anal, both reaching to the base of the caudal, which runs out to an acute point. Muzzle short and rounded. *Cepola rubescens*, in England called band-fish, is represented in *pl.* 83, *fig.* 11.

The family of Theuthydæ, with much the same general appearance with the *Scombridæ*, the same armature of the tail, but in different development, a horizontal spine before the dorsal, &c., differs in the small non-protractile mouth, the single row of occasionally dentated trenchant teeth, the absence of teeth on the tongue and palate, &c., and the single dorsal. They are also generally herbivorous. The genus *Acanthurus* has cutting and serrated teeth, and a strong movable spine in the side of the tail, which is exceedingly sharp, and capable of inflicting a severe wound when incautiously approached. Several species are found off the coast of the United States, as *A. phlebotomus, A. cærulus,* and *A. chirurgus.* This latter species is represented in *pl.* 84, *fig.* 8. The genus *Amphacanthus* presents the highly remarkable and indeed unique feature, of an internal spinous ray to the ventral, as well as the one which is external. There is a con-

cealed spine before the dorsal fin. *Amphacanthus corallinus* (*pl.* 83, *fig.* 3) is from the Seychelles.

The family of Fistularidæ is characterized by a long tube in the forepart of the cranium, formed by the prolongation of the ethmoid, vomer, opercules, pterygoid, and tympanic bones. The mouth is placed at the extremity, as usual. The ribs are short, or absent. The body is either cylindrical, as in the *Fistulariæ*, or compressed, as in the *Centriscus*. The genus *Fistularia*, known as the tobacco-pipe fish, is represented on the coast of the United States by several species, which are readily recognised by their greatly elongated, nearly cylindrical body, the dorsal far back and opposite to the anal, and the filament proceeding from between the two lobes of the caudal. The genus *Centriscus*, in addition to the tubular snout, has a compressed short body, of which the head forms the greater portion of the whole. The tubular mouth is probably used in drawing up their food, as by a syringe. *Centriscus scolopax* (*pl.* 81, *fig.* 21), a European species, is called in England snipe or trumpet-fish.

The two next families, Gobiidæ and Blenniidæ, formerly united into one, possess a common feature in the slender and flexible character of the spinous rays. There is also no swimming bladder. While the latter, however, have the ventral fins either consisting of two rays, or else absent; the former have them united into a single sucking-disk, or else very closely approximated. In the genus *Gobius* proper, the ventrals are united throughout their entire length, so as to form a concave sucking-disk. There are two dorsal fins, the last of which is long. Some of the species are without visible scales. They are mostly fish of small size, and inconspicuous in their appearance, many of them belonging to the United States. *Gobius alepidotus*, a very rare species, has in several instances been procured, by inland naturalists, from the empty valves of oysters, into which they must have crept before the oysters were removed from the bed. The lump-fish, formerly placed in a distinct family, that of the *Discoboli*, are represented by the genera *Lepadogaster*, *Lumpus*, and *Liparis*, the two latter possessing American representatives. The former exhibits two disks, formed, the one by the base of the pectorals, the other by the ventrals. The dorsal and anal are near the tail. By means of their sucking apparatus these small and otherwise defenceless fish are able to attach themselves to sticks and stones, and thus retain a secure hold in a boisterous sea. In the genus *Lumpus* the pectorals uniting with the ventrals form a single disk. The skin of the back is elevated on both sides, so as to inclose spinous rays in a fleshy ridge. The head and body are short, stout, and deep. The *Lumpus anglorum*, or lump-sucker, is a grotesque-looking fish, found on the more northern coasts of Europe and America, possessing the power of adhering to objects in water, with great tenacity, by means of the sucking-disk. A vessel of water containing several gallons has been lifted up by means of the close attachment of a lump-fish to the bottom. This is one of the few fish which pay attention to the eggs after they are discharged. The male here, as in most other cases of the kind, assumes the office of protector; remaining close to the precious

deposit, even in the presence of man, or other fish. The young, when hatched, fasten themselves to the back and sides of the parent, who thus transports them to safer localities than the shallow water in which the eggs were deposited. The genus *Liparis*, found in the seas of Arctic America, with somewhat the same structure of the sucking-disk as lumpus, is without the fleshy ridge on the back, and has a more elongated and smooth body. There is a single, rather lengthened, dorsal fin. *Echeneis* is by some included in this family. The genus *Callionymus* has the ventrals separated and broader than the pectorals. The gill-openings are reduced to a small hole on each side of the nape. There are no species in American waters.

The first genus of the family Blenniidæ is constituted by *Blennius*, with a single elongated dorsal, the ventrals before the pectorals, and distinct, consisting of two rays, united at the base. Teeth slender, in a single row. The species of this genus are small, lively fish, living among sea-weeds, and possessing, some of them at least, curious crests or cirri over the eyes. They derive their name from the shining mucus with which their skin is clothed. They are numerous in species on the coast of the United States, and form several subdivisions of the old Linnæan genus *Blennius* proper, *Pholis*, *Chasmodes*, &c. One genus, *Zoarces*, with the dorsal, anal, and caudal united, is ovo-viviparous, a peculiarity in all probability shared with it by others. Of this latter genus there are three American species. The genus *Gunnellus*, or butter-fish, has an elongated compressed body, and the ventrals rudimentary. The most conspicuous fish of this family, however, is the wolf-fish, or sea-cat, *Anarrhichas lupus*, armed more formidably with teeth than any other known species of equal size. The dorsal fin is composed of simple rays, and extends from the nape to the tail; the anal likewise reaches to the tail. The body is smooth and shining. The palatines, vomer, and mandibles, are armed with stout, prismatic, grinding teeth, the interior being longer and conical. The wolf-fish is exceedingly voracious, and is the pest of the Arctic seas, where it sometimes attains a length of eight feet. It is likewise quite abundant as far south as Massachusetts, on the one continent, and England, on the other. The flesh is highly esteemed by some, although from its exceedingly repulsive appearance, it is not often eaten, except by the inhabitants of Iceland and Greenland.

The conclusion of Müller's order *Acanthopteri* is furnished by the family Lophiidæ, characterized by the elongation of the carpal bones, upon which the pectoral fin is supported, as on an arm. The branchial apertures are small, in the form either of a circular aperture or a vertical slit.

This family includes genera which are among the most repulsive in appearance of all fishes. Conspicuous in this respect is *Lophius*, known by the very large broad head, slender body, broad and thick pectorals, and other characters. *Lophius piscatorius*, or the fishing-frog, angler, wide-gap (*pl.* 81, *fig.* 23), found in European waters, and *L. americanus*, are fishes which attain to a considerable size, and are objects of interest to fishermen; not so much on their own account, as for the other fishes which

nave been accumulated in their stomachs, and which it is considered worth the trouble to extract. Their extreme voracity causes them to devour whatever comes in their way, and as the animals may be several feet in length, with a breadth of one third the length, the short, wide stomach and œsophagus readily permit a great accumulation of contents. They retain life for a long time after being removed from the water. A curious feature in *Lophius* consists in the possession of two long-jointed filaments on the head, possessing great freedom of motion in every direction, and composed of bone covered by skin, which at the end is dilated into a flattened appendage. The fish conceals itself in a dense muddiness produced by the action of its pectoral fins, and elevates these long filaments above its place of concealment, thus attracting the surrounding fishes to the glittering bait. To this habit it owes its name of fishing-frog. It also exhibits a peculiar structure of the teeth, which are articulated in such a manner as to permit them to be pressed back towards the throat, but maintaining an erect position when they are moved in any other direction. Thus a fish, on being seized and swallowed, readily passes over these jointed teeth, which become depressed for the purpose; but any attempt to return is prevented by the now erect fangs. A genus *Malthea* is still more repulsive in appearance than *Lophius*, various parts of the body being provided with fleshy filaments. The mouth is small and inferior. There are three known American species, some of which possess the power of executing considerable leaps, when left by the tide on the shore. The genus *Batrachus*, with somewhat the shape of *Lophius*, although much smaller and more elongated, is without filaments, except short ones on the edges of the lips. The first dorsal is small, the second low and long. The North American species are three in number, the largest of which, *Batrachus tau*, is known as the toad-fish.

The order *Plectognathi*, distinguished by the internal union of some of the bones of the head, is composed of three families, the *Balistinæ*, the *Ostracionidæ*, and the *Gymnodontes*. The first of these, the Balistinæ, is known by the compressed body and prolonged snout; the small mouth, with a few distinct teeth; the skin roughened by prickles or scales; the two dorsals, the first sometimes replaced by a single spine. The ventrals are often obsolete, and the pelvic bone is prominent. The three principal North American genera are: *Balistes*, covered with large scales; *Monacanthus*, with the scales very small; and *Aluteres*, with the skin covered with small and almost invisible granules.

In the Ostracionidæ the entire body is enveloped by an inferior inflexible triangular, or quadrangular, long case, composed of numerous plates soldered together, leaving only apertures for the mouth and fins. There are no ventral fins, and but a single dorsal. The only North American genus of this family is *Lactophrys*, or trunk-fish, of which there are three species.

The most striking characteristic of the family Gymnodontes consists in the peculiar structure of the teeth. There are either two, or one, in each jaw, occupying its whole extent in a compact mass, and resembling some-

what the bill of a parrot. The teeth are compound, composed of numerous laminæ, which are constantly being renewed as they are worn away. In *Diodon* there is but one such compound tooth, occupying the whole of each jaw: the skin is armed with slender prickles, or stout spines. Several species are known in the United States, the most abundant of which is *D. maculo-striatus*, or the balloon-fish. *D. punctatus* (*pl.* 81, *fig.* 19) is a common species of tropical waters. In *Tetraodon* the single tooth appears to be divided in each jaw by a deep incision, producing four pieces in the mouth. The body is not cased in an inflexible coat, as Diodon, and the dermal appendages are less highly developed. Some species of the genus will inflate themselves to a great extent by swallowing air and causing it to pass into a sac immediately beneath the skin: irritating them will cause them to exhibit this property. When thus inflated they become much lighter than the water, and float about on the surface. The spines with which the body is provided then stand up erect, and furnish a secure guard to the animal. These same remarks apply, in a less degree, to Diodon. One species of *Tetraodon* is electrical, *T. electricus*. *Pl.* 81, *fig.* 20, represents *T. lagocephalus*. Four species are known in American waters.

The remaining genus *Orthagoriscus* is composed of fishes which appear to have had the tail abruptly cut off. The jaws are undivided, as in Diodon, but the skin is not capable of inflation. The high dorsal and anal are united to the caudal. The largest species, *Orthagoriscus mola*, known as the sunfish, or head-fish, is occasionally caught off the coast of the United States. It is a fish of large size, weighing sometimes as much as 400 lbs.

The order *Lophobranchii*, characterized by having the gills in small tufts instead of being pectiniform, is composed of two families, the SYNGNATHIDÆ and the HIPPOCAMPIDÆ, both much restricted in their genera and species. Considering them most conveniently as one family (as we may here), we find three prominent genera, *Syngnathus*, *Hippocampus*, and *Pegasus*. The genus *Syngnathus* embraces fishes with a tubular snout, somewhat like that of the Fistularidæ: the body generally straight and elongated, and the ventrals absent. The whole body covered with plates. The most curious feature consists in the possession by the male of a false pouch under the tail, into which the ova are conveyed by the female, and there hatched; being retained for a considerable time before final expulsion. This is the case in *Syngnathus acus* (*pl.* 81, *fig.* 16). In *Syngnathus ophidion* (*pl.* 81, *fig.* 15) the eggs are merely attached beneath the abdomen, and not protected by lateral folds of the skin. One species, *S. peckianus*, or pipe-fish, is known on the coast of the United States. In *Hippocampus*, called the sea-horse, the body is broader and shorter; the tail, however, is slender: there are no ventral and caudal fins; and an anal only in the females. One species, *H. hudsonius*, is frequently thrown up on the Atlantic beaches of the United States. *Pegasus* has long, broad pectorals, and a mailed body, which is shorter and stouter than that of the preceding. The dorsal and anal fins are opposite. The mouth is placed at the end of a salient snout, but is inferior, not terminal. One of the most

peculiar species of *Pegasus* is *P. draco* (*pl.* 81, *fig.* 17), from the Indian seas.

The order of fishes we have now to consider is one of the most interesting in the whole department of Ichthyology. It includes forms, which, predominating exclusively at the dawn of vertebrate creation, have long since passed away, leaving nothing but the casts or imperfect skeleton remains to bear witness of animals which once inhabited the waters of a Palæozoic age. But few genera of any of these families remain to testify as to what was once the rule, and not, as now, the exception in nature. We may, with some authors, divide all fishes into *Teleostei*, *Ganoidei*, and *Selachii*. The *Teleostei* are fishes with a bony skeleton, the bones of the head being also united by sutures. Other characters are to be found in the structure of the heart, where the bulbus arteriosus is simply an expansion of the aorta, and does not, as in the Ganoids and Selachians, pulsate independently. There are no traces of the transverse fasciculi of the heart, but only pale fasciculi of soft fibres, which taper gradually into an uniform layer of the artery. There are also two opposite valves, separating the bulbus from the heart. The *Cyclostomes* have these valves, but are without the swelling of the bulb. Deferring for the present the consideration of the comparative peculiarities of the Selachian division, we proceed to the *Ganoidei*, the second division of this classification, the ninth order of the one we have already adopted. They form a true bond of union between the *Teleostei* and the *Selachii*, having properties common to both. Their most conspicuous external characters are the possession of angular bony or horny scales, covered with enamel. Their internal peculiarities consist in the multiple valves and the muscular investment of the aorta, in the non-decussating optic nerves, in the free gills and operculum, and in the abdominal ventral fins. Other characters no less important, but more variable in their appearance, are to be found in the single or double series of spinous plates or imbrications in the interior edge of the tail, and in the inequilobal or heterocercal tail, a structure in which the vertebral column, instead of running out to the middle of the caudal fin, has its termination in the upper lobe. This feature is highly characteristic of the *Plagiostomes* of the present day. Some of these, besides the pseudo-branchiæ, have an additional organ of respiration in an opercular gill. Finally, to the above mentioned characters are to be added more or less of the following: the spiral valve in the intestine, the air-duct of the swimming bladder, the discharge of the ova from the abdominal cavity through tubes, and the partly imperfect skeleton; as also the tubular, angular, or round enamelled scales, or bony plates, where any covering whatever exists.

Thus of cartilaginous fishes, they have the accessory gill before the first, the spiracles; the valves and muscles of the aorta, the vascular distribution of the pseudo-branchiæ, the oviducts, and the peculiarity of the optic nerves. Of osseous, or bony fishes, they have these characters: the structure of the nose, the operculum, and the free gills. There is a swimming bladder in all Ganoids, with a free air-duct, and without a *rete mirabile*.

It has already been mentioned that most Ganoids are only known from their fossil remains. The living genera and species are few in number: the *Amiæ* and *Lepidostei* of North America, the *Polypterus* of Africa, and the Sturgeons of both hemispheres, being all that now exist. A convenient division of the Ganoids is into those with a bony skeleton, *Holostei*, and those with a cartilaginous skeleton, *Chondrostei*. In the *Holostei*, while the entirely bony character of the skeleton is the rule, yet an exception is found in some genera, in which ossified ribs and spinous processes are attached to a cartilaginous chorda. The ganoid scales are of various character, and in the first family the scales are even cycloid; other features, however, still retaining it among the Ganoids. A progression also is observable in the really Ganoid scale. At first it is rounded, and with a very slight coating of enamel; then this thickens, and the scale becomes more and more angular, still retaining the imbricated character. Finally, the scales become angular plates, in which a pin in the upper edge of one fits into a depression in the lower border of another immediately above, the whole thus riveted together, as it were, into a coat of mail.

The first family of the *Holostei* is that of Amiadæ, the type of which is *Amia*, a genus of fishes exclusively confined to North America. Most species of this family, as of most of the *Holostei*, are extinct, the recent being only those which belong to the above mentioned genus, and to *Butyrinus*, if this be properly included. The title of *Amia* to a distinct position, as the type of a family, among the *Ganoidæ*, instead of forming, as heretofore, one of the *Clupeidæ*, is mainly to be found in the five or six valves in the aorta. The *Amiadæ* have an elongated, nearly cylindrical body, with a rounded or emarginated sub-homocercal caudal, one dorsal fin, variable in position, and flexible rounded, or subangular, mailed or imbricated scales. The jaws are provided with conical teeth, of greater or less size. The fishes of this family first appear in the Jura, occurring in small number in the Lias. Extending through the middle Jura, they disappear as fossil forms in the Cretaceous, leaving only *Amia* as their now living representative. None occur fossil in America, except a species of *Aspidorhynchus*, probably found in South America. The genus *Amia*, with the general characters already referred to, has the head exhibiting conspicuous sutures; a long dorsal and a short anal; a long buckler between the branches of the lower jaw; branchiostegal rays 12; conical teeth in the jaw, within which are smaller paved teeth. The head is short and rounded; the nostrils have tubular appendages. The most conspicuous feature in the *Amias* is, however, to be found in the air-bladder, which is sub-divided into small cells exhibiting a structure very similar to that of some Reptilia. It is in this genus that the homology of the lung of the air-breathing vertebrate, with the air-bladder of the fish, is most clearly established. *Amias*, of which eight or ten species are known, all live more or less in the muddy bottoms of sluggish streams or ditches; and are generally shunned as repulsive objects unfit for food. They have been found throughout the United States, excepting in those rivers (and their tributaries) which empty into the Atlantic, between the St. Lawrence

and the lower part of Chesapeake Bay. They are called bow-fin in Lake Champlain, dog-fish in Lake Erie, mud-fish in South Carolina, &c.

The next family, the SAUROIDEI, embraces but two genera, *Lepidosteus* and *Polypterus*, both recent. The genus *Lepidosteus* is confined to North America, where it is represented by about ten species peculiar to different sections of country. There are two types of structure in *Lepidosteus*, one with broad short jaws, the other with the jaws very narrow and elongated. The dorsal is single, and placed far back opposite to the anal; and the whole appearance, at first sight, is not unlike a pike, for which reason one species was called by Linnæus *Esox osseus*, or bony pike. The air-bladder presents a cellular character, somewhat like that of *Amia*. The principal osteological features consist in the vomer being divided into two; an upper jaw composed of many pieces, a lower jaw similar in structure to some Reptilia, as also in the vertebræ, one of whose articulations is convex, the other concave. There are two series of imbricated spines on the anterior ray of each fin, the remaining rays being jointed. The scales are combined into an impenetrable coat of mail, of almost adamantine hardness; and the jaws being provided with large conical teeth, with smaller ones interspersed, and on the vomer, give the gar-fish, or gar-pike, a truly formidable appearance. Gars attain a large size, especially the broad-billed species, which has been known to measure ten feet in length. When of proportions like this, it justly deserves the name of "Alligator Gar," from the striking resemblance borne by the head to that of the alligator. It would carry us too far out of our limits to extend these observations to the remaining structural peculiarities of this highly remarkable and unique genus, which ranges the waters of America, an isolated memorial of a past generation.

The genus *Polypterus*, by some justly made the type of a distinct family, consists of four species, found only in the rivers of Africa. The most striking external feature, by which it is distinguished from its nearest ally, the preceding genus, is to be found in the great number of separate finlets along the back, each consisting of a spine with some posterior rays. The body is enveloped in mailed scales, of great hardness, as in *Lepidosteus*. The upper jaw is undivided; the lower, fish-like, not reptilian; the vomer is simple; the vertebræ bi-concave; and the fins without imbrications.

The remaining families of the *Holostean ganoids* are all extinct; and we shall therefore confine ourselves to a brief synopsis only of their characters. But few of the species, hitherto described, belong to North America: these will be referred to in the proper place.

The ROSTRATI have a greatly elongated body, the head running out into a narrow snout. The vertebral column is not much developed, only the head and the ribs being ossified. The dorsal and anal fins are of great development. The scales are variable in shape and number.

The PYCNODONTES were fish of medium, or considerable size, with a short, high, and much compressed body. The caudal fin alone is well developed; the dorsal and anal, which begin in the middle of the body and extend to

the caudal, are composed of weak rays. The ventrals are mostly wanting. In addition to smaller teeth, variously situated, the lower jaw and the roof of the mouth bear several series of broad depressed teeth, increasing in extent, as they occur further back in the mouth. The surface of these teeth is sometimes smooth, sometimes furrowed, and either flat, convex, or concave. The roots of the teeth, which possess an internal cavity, are firmly fixed to the jaw. There are strong sternal ribs, and peculiar slender bones in the nape. The scales are of considerable size, of a thick rhomboidal shape. None of the *Pycnodontes* have as yet been found in North America.

The family of the Lepidotini embraces species of slender form and powerful build, whose anterior fin-edge is provided with a double series of fulcra, or imbricated scales, as in *Lepidosteus*. The inner dental series sometimes have expanded obtuse teeth, the outer exhibits them conical and slender. The caudal fin is always highly developed, attached obliquely, and with the base of the upper lobe covered with small scales. The ventrals are small, the pectorals well developed, and the dorsal of moderate size. The genera of this family first present themselves in the Jura, and disappear at the beginning of the Tertiary. None belong to North America.

In the family Monostichii the anterior fin rays are provided with a simple series of fulcra, which rest by two branches upon the main ray. The body is more and more developed in a vertical direction. All the fins are feebly developed, the caudal most so. The scales diminish remarkably in size, from the sides, where they are greatest and higher than long, towards the back, belly, and tail; becoming equilaterally rhomboidal, or lozenge-shaped. The teeth are acutely conical, or bluntly cylindrical.

The Dipterini homocerci are distinguished from all the preceding families by the two dorsal fins, and from the succeeding by the homocercal or equilobed character of the tail. This is generally highly developed at the expense of the other fins, which appear small in proportion. The forked dorsal fin-rays rest upon the intercalary spines, which in turn are supported immediately by the spinous processes. The head is of moderate size, and the jaws armed with strong, paved, or conical teeth.

Dipterini heterocerci have the double dorsal of the preceding, and a slightly developed, always heterocercal, or inequilobed tail. The bases of all the fins are encompassed by smaller scales; and the anterior ray, instead of fulcra, sustains small close pressed jointed rays, which sometimes form alone the upper lobe of the caudal fin. The body is generally elongated, and the jaws armed with a series of conical teeth, of equal or unequal size. The thin scales pass from rhomboidal to cycloidal in shape, in which latter case they are imbricated over the body. From the configuration of head, they exhibit a remarkable approximation to the living ganoids.

In the family of Acanthodii we find the same heterocercal tail as in the preceding; but the anal fin is simple, and the anterior dorsal soon disappears. Both these median fins, as well as the lateral, have a first strong elongated spine, with neither fulcra nor jointed rays, thus distinguishing the genera of this family from all other ganoids. The exceedingly small scales

give to the skin an appearance like shagreen. Under the lens they seem to be of a rhomboidal form, with the characteristic enamel. The body is generally fusiform, compressed. The head large and broad, the jaws broad, and armed with conical teeth, and opening widely.

The family is represented, in North America, by a single species of *Acanthodes.* The genus is recognised by the projecting lower jaw, the absence of an anterior dorsal, the small caudal, and the very minute scales. The small ventrals lie close together in the middle line of the body and in the middle line of the belly, and the dorsal stands opposite to the somewhat larger anal. The species *Acanthodes sulcatus*, from the carboniferous of New Haven, has regularly rhomboidal scales, with an arched enamelling, and vertically diagonal broad furrows.

In the Heterocerci monopterygii, the larger scales, and the absence of a strong spine in the lateral fins, form the distinctive feature in respect to the preceding family; and the single dorsal separates it from the one before that. The positive characters of the family are very variable; the teeth, however, are generally small and acutely conical, rarely obtuse. The rhomboidal scales are never imbricated. The fulcra on the fin borders are almost always present. It is in this family that most of the American *Holostei* are included. In the genus *Eurynotus*, the dorsal extending over nearly the whole back, with its elongated first ray, is situated anterior to the anal; the body is rather slender; the pectorals are greatly elongated, the ventrals moderate. The head is rather small, the jaws armed with very minute obtuse teeth, the scales of medium size. *Eurynotus tenuiceps*, from the new red sandstone of Sunderland, Mass., and Middletown, Conn., and *E. fimbriatus*, from New Haven, are the American species.

The extensive genus *Palæoniscus* embraces fish of moderate size, with fins of no great development. The body is elongated, or slender, or compact. The head is small and rounded; the mouth deeply cleft, the jaws well supplied with small card teeth; the operculum large and broad, the preoperculum strongly curved. The scales vary in form and size, but always have a rhomboidal outline. The pectorals and ventrals are not much developed, the short anal more so, and still more the long rayed dorsal. The caudal is deeply cleft, and perfectly heterocercal. The American species are: *Palæoniscus fultus*, from Sunderland, Mass., Durham and Middletown, Conn., Pompton and Boonton, New Jersey. *P. carinatus*, New Haven, *P. agassizii* and *P. ovatus*, Middletown, Durham, and Westfield, Conn.; Sunderland, Mass.; Boonton and Pompton, N.J. *P. macropterus*, Sunderland, Middletown, Durham, and Boonton. The genus *Amblypterus*, with some affinities with *Palæoniscus*, exhibits a greater development of fins, and a longer and broader body. The fin rays are thin, short jointed, and split only at the end. The ventrals are anterior to the middle of the body, the dorsal in the middle, the extended anal only a little behind it. The moderate scales are rhomboidal, smooth, or furrowed. The head is provided with large orbits and opercular pieces, the powerful jaws

are furnished with card teeth. The American species are: *Amblypterus nemopterus* and *A. punctatus*, from New Haven.

We now proceed to take up the consideration of the cartilaginous *Ganoids*, or the *Chondrostei*, which are represented in the living fauna by the *Sturionidæ*, and are characterized by the cartilaginous vertebral column, and by other features, which will appear in the description of the families. The genera of the Sturionidæ are all found in America, two of them being peculiar to it.

In *Polyodon* the snout is enormously prolonged, and much dilated, and, together with the head, is nearly as long as the body. The gape of the mouth is very wide, and the operculum is prolonged behind into a membranous flap, this reaching beyond the middle of the fish. The tail, as in all *Chondrostei*, is highly heterocercal, and the skin entirely naked. The single species *Polyodon folium*, is an inhabitant of the waters of the Mississippi, where it attains to a size of five feet, although usually not more than one or two. It bears the various names of spoonbill, spade-, paddle-, or shovel-fish, and is by some considered a great delicacy for the table. The teeth are very distinct when young; but when old, the species become edentulous, in which state it has been mistaken for a different form.

In *Acipenser* the fusiform body is prolonged into an acute snout, projecting beyond the transverse protractile mouth, and with several depending cirri. The skin is furnished with several rows of large plates, more or less developed, with ganoid granules, or smaller plates, interspersed. Of the larger plates there is one row on the back, one on each side, and two or more on the belly. The preoperculum is absent, and the caudal termination of the vertebral column is provided with a fin above. The sculpture on the head, and the arrangement and character of the plates, furnish good specific characters. The American species of this mostly fluviatile species have not yet been distinctly defined; the number, however, is quite considerable. They bear the generic name of sturgeons, and attain to a great size. The oil is sometimes collected for economical purposes, and the flesh by some is highly esteemed. On the Hudson river it is called "Albany beef," from its frequent exposure in the markets of that city. The European *Acipenser ruthenus*, and *A. sturio*, are represented in *pl.* 81, *figs.* 24 and 25. It may perhaps be worthy of mention, that most of the isinglass of commerce is furnished by the air-bladders of sturgeons. In the genus *Scaphirhynchus*, found associated with *Polyodon*, we have a much greater development of the dermal plates than in *Acipenser*. The posterior half of the body is entirely embraced by these sharply angular plates, and is of a remarkably depressed, though highly attenuated form. The upper edge of the caudal extremity of the body is bordered by imbricated scales, instead of regular fin-rays. The snout, also, is broader, and more shovel-shaped than in *Acipenser*, and the whole fish more slender. But one species, the *Scaphirhynchus platirhynchus*, or shovel-fish of the Mississippi waters, is known.

The remaining families of the *Chondrostei* are composed of entirely extinct species, and among them we find the oldest forms known to the

palæontologist. The family of *Cephalaspides* exhibited features so bizarre, as to cause them to be placed anywhere else than among fishes: it was Agassiz who first recognised their true character, and placed them in the position to which they properly belong. The essential character is to be found in the broad, tesselated, bony plates, which encircle the head and a part of the trunk. The form, number, and arrangement of these, vary greatly in the different genera, although they possess one general character in the enamel coating, the smooth inner face, and the variously marked or granulated exterior. The head is covered by a simple or compound, always flat, buckler, of various characters. The body, like the head, is flat, and variously covered with plates. The fins exhibit a peculiar development, the ventrals are entirely absent, the pectorals of a narrow rayless plate, situated behind the head, produced more or less into a wing. With a single exception, the caudal fin is entirely wanting, and the dorsal and anal, when developed, never attain to any considerable size. In the structure of the skeleton they exhibit some close affinities to the sturgeons. No species have as yet been found in North America.

The concluding family of the *Chondrostei*, Holoptychii, is composed of fishes with slender and powerful bodies, thick heads, wide jaws, and well developed fins. The jaws are furnished with small, sharp teeth, at the edge, and with a few others that are very large, strongly conical, at considerable distances apart; these, with the fins, indicate a highly predacious character. All the teeth are covered with vertical folds, which become lost towards the apex. The scales, in form and arrangement, resemble those of the true cycloids, and overlap each other in oblique series. Their coating of enamel, however, indicates clearly their ganoid structure. Even the bones of the head are covered with enamel, and variously sculptured on the surface. The fin rays and bones, as far as these exist, possess internal cavities, an unique character peculiar to these fish. The genera belong to the old red sandstone and the Devonian, but it is doubtful whether any species, either of this family or of the preceding, occur in North America. The reported occurrence of *Holoptychius nobilissimus* in Pennsylvania and New York wants confirmation.

Before commencing the consideration of the truly cartilaginous fishes forming the division *Selachii*, as distinguished from the *Teleostei* and *Ganoidei*, it will be necessary to dwell for a moment upon the ninth order of the tabular classification placed at the head of our article, and constituted by a single family, the Sirenoidei. This family includes two species, of, perhaps, two different genera, the *Lepidosiren paradoxa* from Brazil, and *Lepidosiren*, perhaps *Protopterus annectens*, from the Gambia River, Africa. By most Continental naturalists the *Lepidosiren* is considered to be a reptile, while Professor Owen is confident as to its ichthyal character. It in fact combines the characters of both reptile and fish, to a most remarkable degree, the African species inclining more to the latter, the South American to the former. Deferring further consideration of the subject until we come to the class of Reptiles, we proceed to the subject of the *Selachii*, above referred to.

The genuine cartilaginous fishes are distinguished from the two other grand divisions by the undivided skull, with independent jaws, by the covering of all the cartilages with a fine mosaic of tessellated particles of bone, by the fixed gills with spiracles, by the presence of branchial bones, by the absence of gill covers, by the extension of the labyrinth of the ear out to the skin, and by the structure of the organs of generation.

In spite of all these differences, however, there are, as already mentioned, many analogies between the *Selachii* and the *Ganoidei*, these consisting of the number of valves in the aorta, the muscular investment of the bulbus arteriosus, which pulsates like a true heart, and of other features already mentioned. The most striking difference lies in the peculiar sexual apparatus of the former. The Selachians of the present day are divided into two orders, the ***Plagiostomi*** and ***Holocephali.*** The former have distinct jaws, and a well defined, often entirely osseous, column of vertebræ. In the *Holocephali*, or *Chimæræ*, the jaws are fused to the skull, and the vertebral column is only a soft vertebral cord. The two divisions are represented by both fossil and recent forms in variable proportion.

The ***Holocephali***, in addition to the characters already mentioned, have a single lateral gill opening; two dorsal fins, the first being a simple dentated spine; the tail running out into a fine thread. The teeth are composed of great plates, which rest upon the uninterrupted anteriorly prolonged base of the skull; upon the lower jaw they articulate in the cartilage of the skull. The two living forms are *Chimæra* and *Callorhynchus*, the former well deserving the name. The *Chimæra* has a simply conical snout, the second dorsal immediately behind the first, and extending to the tip of the tail, which is drawn out into a long filament. *Chimæra monstrosa*, the only species, is abundant in the Arctic seas. *Callorhynchus* has a fleshy appendage to the snout; the second dorsal commences over the ventrals, and terminates opposite to the subcaudal fin. The single species, *Callorhynchus australis*, is a native of the Antarctic Ocean.

The order ***Plagiostomi*** has a cartilaginous cranium, in which the individual parts are not recognisable; cartilaginous dentigerous jaws attached to the cranium, also by cartilages. The face is prolonged anteriorly; and in its under side, at a greater or less distance from the extremity, opens the broad transverse mouth, near to which are five or more lateral spiracles or gill openings, before it the two nasal fossa. The vertebral column always exhibits greater or less indication of transverse separation. Ventrals and pectorals are always present, but like the other fins they are soft and fleshy. The external investment consists of shagreen, or of small plates variously modified. The teeth are placed on the roof of the mouth and the lower jaw. The swimming bladder is wanting, and the intestine is provided with a spiral valve. We distinguish two principal divisions, or sub-orders, *Squalidæ*, sharks, with the branchial fissures lateral, eyelids free, scapular arch incomplete, pectoral fins distinct from the head, body slender, fusiform; and *Raiadæ*, or rays, fish with depressed body, spiracles, five branchial fissures on the ventral surface of the body, beneath the pectoral fins, the upper eyelid grown to the eye, or eyelids absent,

the scapular arch complete, and the pectoral fins continuous with the head.

Sub-order 1. *Squalidæ.*

A. Two dorsal fins, one anal. First dorsal above, or posterior to the ventral.

Fam. 1. Scyllini. With spiracles, and no nictitating membrane; five branchial fissures; an oral groove; pectorals broad; anal anterior, posterior, or inferior to the second dorsal. Caudal elongated, truncate, or rounded at the extremity. No caudal furrow. Teeth with a median cone, and one to four lateral denticles. Colors lively. Ex.: *Scyllium, Pristiurus.* Recent genera seven.

B. Two dorsal fins, and one anal. First dorsal between the pectoral and ventral.

a. Without spiracles, and with a nictitating membrane.

Fam. 2. Carchariadini. Teeth triangular, flat, with cutting edges, smooth, or denticulated. Anal fin opposite the second dorsal, or nearly so. A small triangular notch generally present, above and below the base of the caudal fin. The nostrils have generally a small triangular valve at the upper border. Convolution of the intestinal valve, longitudinal, not helicoid. Scales small, skin smooth. Ex.: *Carcharias,* with five sub-genera (*Prionodon obscurus,* United States), *Sphyrna. S. zygæna* is the curious hammer-headed shark. Several species of the genus are found fossil in the United States. *Pl.* 84, *fig.* 1, represents *Carcharias verus ; pl.* 81, *fig.* 26, *Sphyrna malleus,* the hammer-headed shark of Europe.

Fam. 3. Triænodontini. Valve of the nostrils broad, or even prolonged into a cirrus. Teeth much as in *Scyllini.* Anal and second dorsal nearly opposite. Caudal notches or furrows, present, or absent. Scales with three to seven ridges. Ex.: *Triænodon.*

b. With both nictitating membrane and spiracles.

Fam. 4. Galeini. Spiracles small, longitudinal, or round. Teeth in both jaws equal, flat, with cutting edges; the jaws oblique externally, anal nearly opposite to the second dorsal. The upper lobe of the caudal fin with one or two notches anterior to the extremity. Convolutions of intestinal valve either longitudinal or helicoid. Scales small, three-ridged, with a central point. Ex.: *Galeus.*

Fam. 5. Scylliodontini. Snout obtuse. Valve of nostril broad, and tolerably long. Spiracles moderate. Teeth as in *Scyllini,* one large central fang, with several lateral at the base. Shape of the fins as in this family, the lower lobe abortive, and the caudal furrow wanting. Ex.: *Triakis.*

Fam. 6. Mustelini. Spiracles large. Nictitating membrane appearing like a duplicature of the lower eyelid. Teeth depressed, without point or cutting edge, as in *Raiadæ.* First dorsal nearly intermediate between pectorals and ventrals. Valve of intestine helicoid. Ex.: *Mustelus.*

c. Nictitating membrane wanting, spiracles present.

Fam. 7. Lamnini. Branchial apertures large, and anterior to the pectorals. Caudal furrows evident. Caudal fin semilunate. A ridge on each side of the tail. Spiracles very small. Intestinal valve helicoid. Second dorsal, and the anal small, and opposite to each other. Ex.: *Lamna, Oxyrhina, Selache. S. maxima* is the gigantic basking shark of the coast of the United States.

Fam. 8. Odontaspidini. Branchial apertures large, all anterior to the pectorals. Anal and second dorsal large. Upper lobe of the caudal fin elongated, as in Carcharias. The lateral ridge of *Lamnini* is wanting. Ex.: *Odontaspis.*

Fam. 9. Alopiadini. Snout short and conical. Spiracles very small. Nostrils small, with a small valve at the upper border. No labial cartilage. Branchial apertures small, the last standing over the pectorals. Teeth triangular, flat, with cutting undenticulated margins, the same in both jaws. Anal and second dorsal opposite, very small. Upper lobe of caudal fin very long; a furrow at its base. Intestinal canal helicoid. Ex.: *Alopias.*

Fam. 10. Cestracionini. Mouth at the anterior border of the snout. Nostrils extending to the mouth. Distinct spiracles. A spine before each dorsal. Ex.: *Cestracion.* The single living species, *C. phillipsii*, or Port-Jackson shark, is of great interest on account of the peculiarities of its anatomical structure, which exhibit a close relation to many extinct forms.

Fam. 11. Rhinodontini. Mouth and nostrils at the anterior extremity of the flat head. Teeth exceedingly small, conical, very numerous. Spiracles very small. Ex.: *Rhinodon.*

c. An anal, and but one dorsal.

Fam. 12. Notidani. A median tooth in the lower jaw. Ex.: *Heptanchus, Hexanchus.*

d. Anal fin absent.

Fam. 13. Spinicini. A spine before each dorsal. Ex.: *Acanthias, Spinax. Pl.* 81, *fig.* 27, represents *Spinax acanthias.*

Fam. 14. Scymnini. Dorsal fins without spines. Ex.: *Scymnus.*

Fam. 15. Squatinini. Pectoral fins very broad, the base extending to the head, but separated by a fissure. At the bottom of this fissure are situated the branchial apertures, which follow in close succession, and are only separated by membranous laminæ. Ex.: *Squatina.*

Sub-order 2. *Raiadæ.*

Fam. 16. Pristidini. Body elongated; snout prolonged into a long saw, with teeth implanted in the two edges. Ex.: *Pristis. Pristis antiquorum* is the saw-fish found in various parts of the globe (*pl.* 82, *fig.* 2).

Fam. 17. Rhinobatini. Body rhomboidal, elongated; tail thick, fleshy; dorsal fins two, remote; caudal fin terminal; teeth minute, paved, arranged in quincunx. Ex.: *Rhinobatus.*

Fam. 18. Torpedinini. Body orbicular; head margined by the extended pectorals; tail thick, depressed at the base, moderately long, the fin terminal, large, triangular; teeth small, acute; a peculiar electrical apparatus in

the anterior part of the body. Ex.: *Torpedo.* An American species of this family has recently been described.

Fam. 19. Rajini. Head margined by the broad pectoral fins; body rhomboidal; tail slender, elongated; two dorsal fins; teeth slender, numerous; polymorphous, arranged in quincunx. Ex.: *Raia, Uraptera.* The species of *Raia* are numerous in various parts of the world. *Raia batis* is represented in *pl.* 85, *fig.* 1.

Fam. 20. Trygonini. Head margined by the broad pectorals; tail slender, with a strong serrated spine; teeth minute, paved, arranged in quincunx. Ex.: *Trygon.*

Fam. 21. Anacanthini. Similar to the last, but without the caudal spine. Ex.: *Anacanthus.*

Fam. 22. Myliobatini. Head ovate, separate from the broadly acuminate pectoral fins; tail very slender, elongated; dorsal fin with a strong serrated spine; teeth large, paved somewhat like mosaic. Ex.: *Myliobatis, Ætobatis, Rhinoptera.*

Fam. 23. Cephalopterini. Head truncate, with foliaceous appendages on each side; pectorals very broad, laterally extended; tail very slender, elongated; dorsal fin with a serrated spine; teeth minute. Ex.: *Cephaloptera.* Species of this family, some of them of immense size, are taken in Delaware Bay, as well as on other parts of the coast of the United States. They are universally known to American fishermen by the name of "devil-fish," and individuals have been captured measuring eighteen feet across the back.

Fish belonging to the family *Trygonini*, above referred to, abound in the sounds which extend along the coast of New Jersey, where they are called "sting-rays," or more commonly "sting-rees." They have been known to inflict severe, and often very dangerous wounds, with the spine of the tail, when handled incautiously.

In the above enumeration of the families of the *Selachii* we have departed from our usual custom of illustrating the different sections by special reference to North American genera and species. Unfortunately, the materials at our command, owing to the little attention paid to the subject by American naturalists, are too scanty to permit any accurate comparisons or indications of the kind desirable. The fossil species have recently been ably worked up by Dr. R. W. Gibbes in a monograph published in the Journal of the Academy of Natural Sciences. From this valuable paper we find that there are 6 fossil species of *Carcharodon,* 6 of *Galeocerdo, Hemipristis* 1, *Glyphis* 1, *Sphyrna* 3, *Notidanus* 1, *Lamna* 9, *Otodus* 7, *Oxyrhina* 9, *Pristis* 1, *Spinax* 1, *Hybodus* 1, *Myliobatis* 2; making 13 genera, and 48 species.

VERTEBRATA.

Class II. Reptilia.

The Reptilia are cold-blooded vertebrates like fishes, but are distinguished from these by the pulmonary respiration, the heart with three chambers, the presence of organs of motion other than fins, and by various other points of organization.

The circulation of the blood is incomplete; less complete even than in fishes. The heart consists of two auricles and one ventricle. The venous blood, collected from the various parts of the body, accumulates in the vena cava, and thence passes into the right auricle. From the right auricle it passes into the single ventricle, and by it is impelled through the aorta into all parts of the body. A small branch leads to the lungs, and the blood when purified is returned to the left auricle, which drives it into the ventricle. This ventricle thus receives venous blood from one auricle, arterial from the other, and it is a mixture of this kind which is distributed through the body. The naked skin of the *Batrachian* reptiles serves a good purpose in the decarbonization of the blood, owing to the extensive distribution of bloodvessels immediately on the under side of the skin.

The blood of Reptilia is characterized by the possession of the largest globules to be found in the entire vertebrate sub-kingdom. These, in the tailed batrachians, as *Siren*, &c., are distinctly visible to the naked eye. As in fishes and birds these globules are elliptical in outline; in mammalia, with the single exception of the *Camelidæ*, they are circular.

The lungs lie free in the abdominal cavity; these, with the heart, not being separated from the other viscera by a diaphragm. The cells of the lungs are of greater or less subdivision; in many of the North American *Salamandræ* they are mere sacs. Reptiles are better able to sustain the deprivation of oxygen than other vertebrates: this, however, depends greatly upon the temperature and season. Thus a frog will bear the deprivation of atmospheric air in summer for a space of time not much exceeding two hours, while in winter it can sustain its absence for several days.

A point of great physiological interest in the structure of reptiles consists in the fact that some forms present, at different times of life, both fish-like and reptilian features of respiration. Thus the salamanders and frogs, when young, respire for a certain length of time, for years in some, by means of external gills, the lungs being entirely rudimentary. In course of time the lungs acquire a greater development, and the gills disappear. This fish-like condition of things, transitory in some, is permanent in others, as in *Menobranchus*, *Siren*, and *Proteus*, which throughout life possess external gills.

So true is it that the skin in the naked reptilia is accessory to the function of respiration, that the experiment has been tried with perfect success as to how far respiration might be carried on entirely by means of the skin. Thus the lungs of the frog have been tied in such a manner

as to prevent the access of blood to these organs, yet the animal appeared to experience but little inconvenience.

All Reptilia are cold-blooded, that is, are not able to maintain a uniform temperature, this being regulated, within certain limits, by that of the external air. Variations of external temperature, however, exercise a great influence upon the functions of these animals. Many species are sensibly affected by a temperature of 120° F., and the other extreme of cold retards the activity of living animals, and even destroys them altogether. The salamanders, however, are capable of sustaining a considerable degree of cold without its having any effect upon the system. Thus *Notopthalmus viridescens* has been seen frozen up in ice, yet exhibiting a considerable degree of activity when liberated. In many reptiles torpidity ensues upon a certain reduction of temperature.

Most reptiles possess the four typical vertebrate extremities, two anterior and two posterior, serving either for running, leaping, or swimming. These, however, are not characterized by external development, being generally short in proportion to the rest of the body, so that the belly either drags along the ground, or nearly touches it. The *Ophidia* are, however, destitute of limbs, either entirely, or possess them only in a rudimentary state. Other forms again, as among the *Scincidæ*, have only two hind feet, while others, as *Siren*, possess the anterior pair alone.

There is a much greater difference in the skeleton of different forms of Reptilia than among birds and mammalia. The bones are characterized, microscopically, by the cellular structure and the almost entire absence of central cavities. The cranium is exceedingly small in proportion to the entire head. The skull, on examination, will be found to exhibit more pieces than that of the mammal or bird, owing to the fact that fusion among the individual elements does not take place to anything like the extent observed in the classes just mentioned. Certain bones of the mouth, as the sphenoid and vomer, are armed with teeth; a condition of things which does not again recur, although existing in fishes. In the scaly reptile the articulation of the vertebral column with the head is by means of a single occipital condyle placed below the foramen. This is spherically convex, and produced by the combination of the basi- and ex-occipitals. In the naked forms, however, the basi-occipital retreats from this position, and the single condyle is divided into two, one on each side. These thus represent mammalia in their double condyles, while the squamiferous forms resemble birds and fishes, in having a single occipital articulation between the skull and vertebral column.

The vertebral column of the reptiles is highly characteristic of the class. In most recent adult forms the articulations are spherically convex at one extremity, and spherically concave at the other. The dried skeletons of some of the *perennibranchiate batrachians*, as *Proteus*, *Menobranchus*, as well as of the young *caducibranchiates*, exhibit the biconcave structure of the fish vertebra. This, however, is only an apparent deviation from the law, as in most instances it will be found that the gelatinous ball, representing the convex part of the articulations, has dried up, and thus disappeared.

The number of vertebræ varies exceedingly. Thus in *Pipa* there are seven, and in *Python* upwards of four hundred. The ribs, also, occur in various stages of development. In many of the *anourous batrachians*, they are entirely wanting. They are very numerous in serpents, where, however, they are not attached to a sternum. In the Crocodile family, the entire thorax is highly developed. In the *Chelonia*, the ribs and sternal plates are so expanded as to form a continuous investment for the body. The entire bony structure of the turtles presents considerable deviations from the usual type.

Each class of vertebrate animals possesses a form capable of sustaining itself in the air, to a greater or less extent. Thus, among fishes, the *Dactylopterus* and *Exocœtus* exhibit a power of feeble flight, as a means of escape from their rapacious fellows. Flying is the rule, not the exception, in birds. The bat, among mammalia, can sustain itself in the air by a true process of flight. The *Pteromys*, or flying squirrel, and some other forms, can glide through the air for a certain distance by means of the expansion of the lateral folds of skin, which are stretched by the agency of the limbs. In reptiles, the *Draco volans* exhibits the same power to the degree possessed by the last-mentioned mammal. A lateral fold of skin, supported on several ribs, enables this animal to pass to a considerable distance through the air. An extinct form of reptile, the *Pterodactylus*, possessed a power of flight much like that of the bat of the present day. The general apparatus is similar in both, the principal osteological difference being this, that in the reptile but one finger was used to stretch the wings, while in the bat four are employed for the purpose.

The muscles of reptiles are strong, but not well provided with blood, and consequently exhibit rather a bleached appearance. They retain their irritability for a long time after life may reasonably be supposed to be extinct. Thus the head of the snapping turtle, *Chelonura serpentina*, will snap at a stick touching it, twenty-four hours and more after decapitation. The removal, too, of a great part of the brain, or the severing of the spinal cord, is far from producing the same immediately injurious effect as is found to supervene in birds and mammalia.

The brain of reptiles, although superior to that of fishes, is yet considerably inferior to that of birds. It, however, fills up the cranial cavity to a much greater degree than that of the class last described. The surface of the brain is smooth, without lobes. The two halves of the cerebrum are ovate, and are hollowed out into capacious ventricles. The optic lobes are exposed, or not covered by the backward prolongation of the cerebrum. The cerebellum is minute, and nearly median. The medulla oblongata is large in respect to the rest of the brain, and the nerves have a proportional thickness at their exit, exceeding the higher vertebrata in this respect.

Two modifications of the skeleton are met with among reptiles, a naked skin as in the *Batrachia*, and a series of scales or plates as in the remainder of the class. The tessellated epithelium covering the naked skin is continually being shed, in patches, or entire, and is generally swallowed by the toad and frog. The epithelium of the scaled reptiles is generally shed in

one piece, as may be seen to great advantage in the case of the *Ophidia*. This epithelium is continuous over the cornea in the serpent, and comes off from the latter in a sub-transparent disk like a watch-glass. It is to an opacity resulting from the partial separation of this epithelium from the subjacent cornea that the temporary blindness of these animals is due. Some of the naked reptiles are provided with glands, distributed partially or entirely over the whole surface, from which a more or less acrid juice exudes. This may be seen conspicuously in the toad, and the salamanders of the genus *Ambystoma*.

The apparatus of hearing also exhibits a condition intermediate between that of the fish and the bird. In the fish there is no external ear and no tympanum, the apparatus being represented only by the internal ear. A tympanum is observed, for the first time, in the anourous batrachians; and a meatus exterior to this in most of the *Squamifera*, the *Ophidia* excepted. The apparatus of vision is not very highly developed. The sclerotic membrane, in some cases, has a bony ring, developed either in one piece or in several, as in birds. The nasal apparatus is but slightly developed: the posterior nares perforate the palatal bones. The tongue is sometimes thick and fleshy, in which case it generally serves as an organ of prehension, as in the Batrachia, which catch their insect prey in many cases by means of a viscid secretion borne in the tip of the tongue. In the chameleon the tongue can be protruded to a great length for the same purpose. In general, this organ is thin and horny, or cartilaginous. It is sometimes bifurcated, as in the serpents.

All reptiles, the Chelonia, and some of the caudate batrachians excepted, have teeth, whose office is rather one of prehension than of mastication. These teeth are either inserted in sockets, as in the *Rhizodonta*, represented by the alligator; or, secondly, anchylosed to processes of the jaws; or, thirdly, attached to the inside of a thin vertical plate passing round the mouth. Teeth may also exist in the vomer, as in the North American salamanders. The peculiarities of the teeth in serpents will be treated of in the appropriate place.

There is but slight development of salivary glands in most reptiles; owing to the great size of the throat, the food is gulped down almost immediately, without remaining in the mouth. The œsophagus expands into the stomach, from which it is, in many cases, scarcely distinguishable. The most striking exception is found in the alligator, whose stomach presents a very strong resemblance to the muscular gizzard of a bird. The intestinal canal is short and without cœcum. A slight constriction only separates the greater from the lesser intestine. The fæces and urinary secretions are all emptied into an expansion of the rectum, the cloaca; and there is but one orifice of discharge for all secretions and excretions. Through, or into, the same cloaca, pass the oviducts of the female and the vasa deferentia of the male.

The organ of voice is not generally distributed, occurring to any extent only in the anourous batrachians and the crocodiles. The hiss of the serpent and tortoise can hardly be termed voice.

The influence of temperature upon reptiles has already been adverted to: we will only add that in the temperate zones many species exhibit a winter sleep; while this takes place in summer with inhabitants of tropical regions. Soft mud, with many, forms the medium in which they spend this period of repose. The probable effect upon the more vital functions consists in a sluggish and interrupted circulation, and a very slight respiration. Digestion must be entirely destroyed for the time.

With regard to their geographical distribution, no reptiles whatever are found in the far north. They occur sparingly in the higher temperate regions, increasing in number to the tropics.

The fecundity of many reptiles is very great. The frogs and toads lay as many as 12,000 eggs, salamanders from 10 to 40, crocodiles from 20 to 60, serpents 10 to 100, and turtles from 20 to 30. In some, as in many lizards and serpents, as well as in a few salamanders, the eggs are developed before exclusion from the body. This, however, must not be mistaken for the viviparous placental reproduction of the mammalia. In most cases the eggs are laid, covered loosely with sand, mud, or leaves, and developed by the solar heat: in others, again, the animal itself incubates, as in *Python tigris*. Special peculiarities of reproduction will be referred to under the appropriate head. The external investment of the ovum may be simply membranous, or else calcareous: a mucous coating is found in the case of such species as deposit their eggs in the water.

The number of reptiles is not fully known, new ones being described almost every day. Upwards of 1500 are already ascertained to exist, and 2000 may not be beyond the maximum. The *Ophidia* are perhaps the most numerous, and next to these the *Sauria;* the *Batrachia* are more abundant than the *Chelonia*. Furthermore, while serpents preponderate in torrid regions, the batrachians are more properly inhabitants of the temperate zone. Thus, in North America alone there are upwards of 80 species, 50 of them belonging to the *urodelian*, or tailed forms.

Reptiles live partly on land alone, partly in water alone; others, again, occupy either indifferently, or at different times of the year. For this reason, the latter have received the name of *Amphibia* from some zoologists.

The flesh of reptiles is not used as food to any great extent, although there is no doubt of its extreme excellence in many cases. In various parts of the world, however, serpents, large saurians as the iguana and alligator, turtles, frogs, &c., are favorite articles of food. The eggs of turtles, and of the iguana, are highly prized. They are extracted, by some South American tribes, from the oviduct of the living iguana, without any serious injury to the animal. The shell of the *Chelonia imbricata*, or hawks-bill turtle, furnishes the tortoise-shell of commerce. The teeth of the alligator furnish ivory of an excellent quality. Beyond these instances but little economical value attaches to reptiles.

Sub-class 1. Reptilia nuda.

Order 1. *Batrachia.*

We have already spoken of the general characteristics of Reptiles as a class. It now becomes our duty to refer more particularly to the distinguishing features of the subdivisions, taking them up in the order of the preceding systematic arrangement. Our space will not permit us to treat of these interesting animals, beyond giving a brief summary of the families, recent and fossil; with more particular reference to such genera and species as are noteworthy for special properties or peculiarities, or as being conspicuous inhabitants of North America.

The most striking external character of the *Reptilia nuda,* or the *Batrachia,* is to be found in the perfectly naked, moist skin. This single character, conspicuous at first glance, does not yet express all the points of difference; and indeed, of itself, would be far from justifying us in making a distinct class of the *Batrachia,* as some authors have done, or even perhaps a separate order. An important feature is to be found, as already mentioned, in the double occipital condyles, one on each side of the foramen occipitale, constituted by processes from the ex-occipitals, into which the basi-occipital of Professor R. Owen does not enter as in the *Squamata.* The skull is depressed and broad, the face having a great development at the expense of the cranium, which, with its inclosed brain, is small. It is unnecessary for us, in this general description, to do more than present the naked skin (the only exception to which is to be found in the *Peromeles*), and the double condyles (the latter shared, however, by the *Sauroid Labyrinthodonts*): the other peculiarities, by which the *Batrachia* differ from the scaled reptiles, will fall with the greater propriety under more special heads.

The *Batrachia* are appropriately divided into three orders: the first, *Batrachia urodela,* having a distinct tail, with the limbs either four (represented by the *Salamanders*) or two; the *Batrachia anoura,* with the tail wanting, but with four legs, always present in the adults, as in the frogs and toads; and the *Batrachia peromeles,* with very minute scales, but without limbs and tail, the anus being situated at the extremity of the body, as in the *Anoura. Lepidosiren* would constitute a fourth order, by its introduction into the class of *Reptilia,* but it has already been referred to the class of fishes, and the characters of the species are such as almost to place it in either at pleasure.

There is no order in the animal kingdom more interesting to the naturalist and physiologist than the tailed batrachians. This results not only from the variety of forms, but the progressive changes which are observed from an inferior state to a higher, these changes not restricted to the embryonic period of existence, as in most other animals, the rest of the *Batrachia* excepted, but extending over periods sometimes of considerable length. The two principal sections are characterized, the one by the permanent exhibition of lateral spiracles or holes in the neck, the other by

their temporary existence only. Now taking the full series of metamorphoses exhibited by animals of this latter division as the standard, and establishing, as we may, a number of successive stages of development through which the animal passes from the egg to the adult condition, we shall find in the former division instances of different species coming up to each one of all these stages, and its progress there arrested, and its then condition becoming permanent. This will be more fully illustrated in subsequent observations. The characters of the *Batrachia urodela*, as an order, consist, among others, in the permanent tail, the rudimentary ribs, the limbs four or two, the absence of a sternum, the simple lungs, the teeth in both jaws, and the absence of an external ear. They are distributed throughout the north temperate regions of both continents, especially Northern America, Asia, Europe, Northern Africa, Japan, and the Sandwich Islands. Of all these regions North America is most favored in this respect, all the *Tremadotera*, with two exceptions, and the great majority of the *Atredodera*, being found here. Japan comes next in regard to variety of form, although not in number of species; in this respect, as in many others, exhibiting a remarkable relation to temperate North America.

To give some idea of the changes which are exhibited by the tailed batrachians, in their progress from the embryonic condition to the adult state, we will take a particular example in the case of a species of *Ambystoma*, *A. punctata*, a salamander quite common in the United States, and whose descriptive features will be referred to hereafter. Early in April, or towards the end of March, large masses of a gelatinous matter may be observed in ditches, pools of water, or mountain streamlets, which on closer inspection will be found to consist of a number of hollow spheres, about a quarter of an inch in diameter, embedded in or combined together by a perfectly transparent jelly. Within each sphere is a dark object, a spheroidal yolk, which in the course of some days becomes considerably elongated, and exhibits signs of animation. Omitting, as unsuited to our pages at present, any account of the embryonic development of the animal, we resume its history at the time when its struggles have freed it from the shell of the sphere in which it was inclosed. At this time it is about half an inch in length, and consists simply of head, body, and tail, the latter with a well developed fin, extending from the head and anus to the extremity of the body. Respiration is performed by means of three gills projecting from each side of the neck, of very simple construction, however, and with but few branches. The absence of limbs is compensated by the existence of a club-shaped appendage on each side of the head, proceeding from the angle of the mouth, and representing the cirri observed in some adult salamanders. By means of these appendages, the young salamanders are enabled to anchor themselves securely to objects in the water. In the course of a few days a tubercle is seen to form on each side, just behind the head and under the gills, which elongates, and finally forks at the end, first into two, then three, and at last into four branches, thus exhibiting the anterior extremities, with the four fingers, which latter,

in the larva, are very long. Before the forelegs become completely formed, those behind sprout out in a similar manner, with first three, then four, and finally five toes. During this time the gills have increased in the number of branches, and finally exhibit a beautiful arborescent appearance. in which the circulation of the blood can be distinctly seen by means of a simple lens. At the time, then, that the individual has attained its perfect larval state, it has four legs, with four fingers on the anterior, and five on the posterior; the jaws are wide, the mouth well provided with teeth; the superior maxillary bones, however, not developed, and the pterygoid bone with card teeth, as in *Proteus*, *Menobranchus*, and *Siren*. The animal presents a perfect fac-simile of the Mexican axolotl, which, although by many naturalists considered to be a permanent form, is, in all probability, only a larval state of some very large species of salamander. Our animal is now exceedingly voracious, devouring tadpoles, and weaker larvæ of its own species, with great avidity. Its entire food, in fact, has consisted throughout of animal matter in some form or other. This state of things, in all probability, continues from one spring to the next, or for nearly a year: at the expiration of which time the gills will be seen to wither gradually away, the lateral holes in the neck to grow together, and all these traces of larval life finally to disappear. The superior maxillary becomes developed and ossified, the temporary teeth in the roof of the mouth vanish, the lungs acquire a great development, yellow spots break out of the dark ground of the body, and finally the animal leaves the water, never to return to it again except for a short period in the spring of the year, when it is engaged in the function of reproduction. Such is a brief outline of these changes, which vary in different genera and species.

Proceeding now to the more particular consideration of the *Batrachia urodela*, we commence, first, with the sub-order *Trematodera*. Here we find that the apertures in the side of the neck remain open throughout life, and in several genera even the gills are persistent. The first genus that would come properly here is that of *Siredon*, or the *Axolotl*, whose distinguishing characteristic is to be found in the opercular flap being detached from the subjacent integuments, and continuous across the throat. The gills and gill-openings are very highly developed, the tail strongly compressed, and provided with a well developed fin. Toes, four in front, five behind, all much elongated. Two species have been described, the one *S. mexicanus*, from the lakes in the vicinity of the city of Mexico, the other *S. maculatus*, from the New Mexican Rio Grande. For reasons above mentioned, we prefer to consider them as larvæ, and proceed to the consideration of the genus *Proteus*. The single species of this genus, *P. anguinus*, has long been an object of great interest to naturalists, on account of its individual features, as well as the circumstances under which it is found. It is an inhabitant of the subterranean waters of Sittich in Lower Carniola, and of the great cave of Adelsburg on the main road from Trieste to Vienna. Occasionally it has been caught in the external outlets of these waters, but, like the blind fish of the Mammoth Cave of Kentucky, its usual residence is at a distance of some miles from

the entrances of the caves. Its color is a pale reddish white, and, like the fish above mentioned, it is blind, although rudiments of eyes are discoverable under the integuments by dissection; differing in this respect from the *Amblyopsis spelæus*, or the blind fish, which has not even rudiments of eyes. The body is elongated and slender, the head depressed, but the muzzle rather broad; the anterior feet are provided with three toes, the posterior with two. The gills are well developed, but, unlike the *Axolotl*, the opercular flap is not free, but united to the subjacent integument, so that there are simply the two lateral cervical slits or fissures. It in fact presents a magnified and quite striking likeness to the larva of the American *Spelerpes longicauda*, with the exception of the adnate opercular flap. The fish-like character is also exhibited in the biconcave vertebræ, which, however, may be produced by the drying up in the prepared skeleton of the gelatinous bulb which constitutes the convex articulation of the higher larvæ. It is highly probable that *Proteus* is ovo-viviparous, although the fact has not been distinctly ascertained. Closely related to the *Proteus* is the genus *Necturus*, peculiar to North America. The form of this genus is stouter than that of the last, and there are four toes to each foot. Of the three species known, the first, *N. lateralis* (*pl.* 88, *fig.* 2), is an inhabitant of the Mississippi, and the great lakes, Superior, Huron, Michigan, Erie, and Ontario; the second, *N. maculatus*, lives in Lakes George and Champlain; while the third, *N. punctatus*, and differing from the others by its uniform markings, is an inhabitant of the Santee River, South Carolina. In common with the *Menopoma*, they are termed "alligator," in the central portion of the United States; "salamander" or "water-puppy" in some other districts.

The genus *Siren* is also an inhabitant of the United States, being confined, however, to its southern portion. Here, with the external gills of less development than in the preceding genera, the hind legs are entirely wanting, the two anterior being provided with four toes each. The lungs in this genus play a more important part than in the last; the animal, when in full activity, being obliged to communicate occasionally with the air. One species, *S. lacertina* (*pl.* 88, *fig.* 1), attains to a considerable size, and although having the reputation of being venomous, is perfectly free from any power of offence. It is probable that the fossil genus *Orthophya*, from Œningen, belongs to this family.

The family of living *Menopomidæ*, like that of the *Proteidæ*, is, with a single exception, confined to North America. The branchiæ, which are found to exist permanently in the preceding family, here disappear after a certain length of time, leaving a simple perforation on each side of the neck. This, however, is closed up in the genus *Megalobatrachus*, from Japan. The genus *Amphiuma* is known by the anguilliform body, rudimentary feet, and pointed head with two parallel series of teeth in the upper jaw. Of the two species known, one having two-toed feet is found generally in the Southern States; the other, with three toes, occurs in the southern part of the Mississippi valley. *Menopoma* has a stout, flattened body, broad and much depressed head, eyes very minute, skin corrugated

into numerous folds, four toes on the anterior, and five on the posterior feet. The tail is much compressed, and the soles of the feet margined with a fold of skin enabling the animal to move with facility in the water. It is known generally as the "alligator," although, of course, improperly; and spends most of its time in the water, very rarely coming upon land, except possibly at night. These animals are exceedingly voracious, feeding on insects, fish, and, in some known instances, small mammalia. They bite at a baited hook, in the spring and autumn, with as much greediness as fishes, and are frequently caught in this way, to the great disappointment of the western angler, who, in most cases, is so much afraid of his prize as to cut the line rather than risk the danger of contact with so repulsive an object. No danger exists, however, as the animal, with his short teeth, is unable to produce any injury, even if willing to do so. It sometimes attains a large size, as upwards of two feet, although the average is, perhaps, twelve or fifteen inches. Little is known of its larval history, except that it loses its external gills when only a few inches long. The known species are *M. alleghaniensis*, from the waters of the Mississippi, and *M. fusca*, from those of South Carolina and Georgia. The next, and last, living genus of this family is *Megalobatrachus*, the most gigantic of all living *Batrachia urodela*. It resembles *Menopoma* closely in appearance, the principal difference being found in the entire obliteration of the lateral cervical foramen. The single species, *M. sieboldtii*, inhabits certain elevated lakes in Japan, where it grows to a great size. One specimen, now or recently living in the Museum at Leyden, exceeds three feet in length, weighing upwards of eighteen pounds.

The passage from the *Menopoma* to *Megalobatrachus* is to be found in a gigantic fossil genus, *Andrias*, from the fossiliferous marls of Œningen. Scheuchzer, who published the first description of the single species, *A. scheuchzeri*, called it *Homo diluvii testis;* being impressed with the idea that the skeleton obtained was human, and, as he thought, entombed by the Noachian deluge. In size it is about equal to that of the Japanese giant, from which it differs in having the peculiar structure of the petrous and pterygoid bones, as well as the great breadth of the head observed in *Menopoma*. The anterior toes are longer in proportion than in the allied genera.

The sub-order of *Atretodera*, to which we are led by the genus *Megalobatrachus*, are without branchial apertures or gills when in the adult state. Although there is a great variety of form in this sub-order, yet it is difficult to constitute more than one family, that of the *Salamandrinæ*. Of the three principal regions of the salamanders, Europe, Japan, and North America, each is characterized by some peculiarity of structure. Thus while most of the European forms have parotid glands, like those of the toad, and one at least of the Japanese is provided with temporary claws, the American alone have teeth on the sphenoid bone: neither is there any vestige of the parotid gland, above referred to, in the latter.

The salamanders were formerly divided into two great genera, *Salamandra* and *Triton;* the former with rounded tail and terrestrial habits,

the latter with compressed tail and aquatic. The necessity of further sub-division has, however, become fully apparent, and the old distinction into land and water salamanders no longer tenable as parallel to any anatomical features. Thus, of the highly natural genus *Notophthalmus*, one species is the most aquatic of all American forms, and the other the most terrestrial; yet the two are so much alike in shape as to render it a matter of some difficulty to distinguish them. Without attempting any systematic arrangement of the genera of salamanders we shall take them up in geographical order, beginning with those of North America.

The genus *Ambystoma* embraces the greatest number of species and those of largest size. Its characteristics are, the entire absence of teeth on the sphenoid bone, the nearly transverse undulating line of vomerine teeth, in a measure forming the chord of the arc constituted by the outline of the upper jaw. The tongue is broad and fleshy, and entirely adherent except at the very edge. The species are mostly stout and clumsy, some of them, as *A. punctata*, *A. opaca*, and *A. jeffersoniana*, terrestrial in their habits, with rounded tail and cylindrical toes; others again sub-aquatic, with a much compressed tail, and short, broad, flattened toes. The genus is found throughout the United States, and across to the Pacific ocean, peculiar species occurring in California, Oregon, and New Mexico. The terrestrial species exude a copious, milky, viscid excretion, from all parts of the body. The development of the larva of the best known species has already been referred to. The lungs have a higher degree of organization than in the other genera, being subdivided into cells of moderate size.

The next genus is *Notophthalmus*, known by the ocellated spot on the back in all but one species, the small rudimentary tongue, the absence of teeth on the sphenoid bone, the arrangement of the vomerine teeth in an acute V, as in the true *Tritons*, the densely granulose skin, the three foramina in the side of the neck, &c. The best known species are, *N. viridescens* (*Triton dorsalis*) and *N. miniatus* (*Triton symmetrica*). The former species is exceedingly abundant throughout the United States, and is entirely aquatic. It has even been kept for more than a year in a glass jar filled with water, coming up to the surface from time to time to take in a mouthful of air. In the spring of the year a broad fin becomes developed along the back and tail of the male, and the feet enlarge with the addition of a black cartilaginous mass on the toes and inside of the thighs, for the purpose of enabling it to hold on to the female. This is done by clasping her round the throat with the hind legs, and retaining the hold for some hours, or longer, jerking her round in the water most unmercifully during the whole time. A quantity of seminal matter is finally discharged, which, becoming diffused in the water, fecundates the ova while still in the lower part of the oviduct. The eggs are laid singly, of an ellipsoidal shape, and invested by a very glutinous coat, by which it is attached to the middle of an immersed leaf, which is then doubled over it by the exertions of the female. The eggs, after remaining for some time in this way, finally give birth to small larvæ, the general character of whose metamorphoses is much the same with that of the species already described. The male

subsequently loses the crest and cartilaginous excrescences of the feet. While it is probable that similar habits are possessed by the second species mentioned, the fact has not yet been observed, and the species only seen in rather dry situations and occasionally exposed to the air during damp weather. This is very rarely the case in other species, which are generally seen only in turning up some log or stone.

The next genus, *Plethodon*, with the fleshy adherent tongue of *Ambystoma*, has two dense patches of card-like teeth on the sphenoid bone. The body is long, slender, and cylindrical, the toes of considerable size. The skin exudes a highly glutinous secretion, and the animal is eminently terrestrial. The eggs are deposited in packages, or aggregations, in moist situations, under stones and logs, not, however, in the water; and the larvæ lose their branchiæ at a very early age. The type of the genus is *P. glutinosus*, and species are found all across the North American continent.

The genus *Desmognathus* is highly conspicuous in the possession of strong ligaments, passing from each end of the transverse crest of the first cervical vertebra and inserted into the lower jaw, preventing any other than a slight opening of the mouth. The occipital condyles, instead of being inclined at an angle with each other and presenting an elongated concavity, are here short cylinders, whose axes are parallel to each other and to that of the body, with the articulating face nearly spherically convex. The species are pretty generally distributed, and inhabit the edges of streams or the waters of marshes, under stones and logs, exhibiting great activity of movement when observed. The eggs are wrapped about the body of the parent, who remains in a cavity of some moist situation until they are hatched, just before which they are probably taken to the water, as in *Alytes obstetricans*. The young lose their branchiæ at a very early age. It may be mentioned of this genus, in conclusion, that the tongue is attached anteriorly, and free posteriorly, and that there are two narrow plates of weak teeth on the sphenoid bone.

The genus *Hemidactylium*, with much the same structure of teeth and tongue as the last, has a granular, rather dry skin, and but four toes to the hind feet. The tail also presents a curious feature, in being thicker in the middle than at either the base or the end.

Œdipus, represented by but a single species from Mexico, has the tongue circular, capable of protrusion from the mouth, two contiguous dense patches of card teeth on the sphenoid, and the extremities of the toes dilated into small disks, as in the *Hylæ* or tree frogs.

Pseudotriton has a structure of tongue and sphenoidal teeth much as in the last, with a thick body, short tail, and simple toes. The species are found in wet situations, under logs or stones resting in the water, or among the loose stones and earth, along the edges, or at the heads of springs. The young retain the branchiæ for a long time, and pass a year at least in the larval state. The principal species are *P. rubrum*, *P. salmoneum*, and *P. montanum*.

The genus *Spelerpes*, with much of the general features of the last, has a

very slender body, with a long tail, which is sometimes much longer than the body. The species are very active in their movements, and inhabit the edges of streams under flat stones. They are distributed throughout North America, although none as yet are known from the regions west of the Rocky Mountains, where, however, it is represented by an allied genus, *Batrachoseps*, with but four toes on the hind feet.

It is among the European salamanders that the genera *Salamandra* and *Triton* are still retained. There are others, however, in considerable number. To the former genus belongs *S. maculata* (*pl.* 89, *fig.* 1), the famed salamander of antiquity, respecting which many fables as to a highly venomous bite and a power of resisting the action of fire were long current. The animal is ovo-viviparous, the eggs being retained in the oviduct of the female until ready for hatching, upon which they are conveyed to the water, and the branchiated young there deposited. The changes experienced by the young, as well as the general appearance and habits of the adult, present a not uninteresting similitude to what is observed in the case of *Ambystoma punctata* already referred to. A remarkable fact, which has been observed in a second species, *S. atra*, will recall a similar provision in the case of the ostrich. The female retains the eggs in the oviduct until they are hatched; the number of young produced amounts, however, to but two, which are born without branchiæ, and consequently without a necessity of being deposited in water. The actual number of eggs laid amounts, however, to about twenty, and the eighteen are destined merely to serve as food for the young larvæ after birth. It has already been observed that the restricted genus *Salamandra* differs from the American genera in the possession of parotid glands. The vomerine teeth form an angular row, the body is thick and clumsy, and the toes are four in front and five behind. A genus, *Salamandrina*, differs from other European genera in the possession of but four toes on the hind feet. The genus *Triton*, differing essentially from the American genus *Notophthalmus*, yet bears a striking external resemblance to it; and the habits, as detailed by Rusconi and others, are also very similar. It was upon species of *Triton* that the cruel experiments of Bonnet, Dumeril, and others, were performed as to the reproduction of lost parts. Toes were cut off, and indeed entire limbs and the tail were removed many times in succession, and an individual lived for many months which had had the lungs extirpated and the entire face cut away, leaving nothing but the cranium. Conspicuous species are to be found in *T. tæniatum* (*pl.* 89, *fig.* 2) and *T. cristatum* (*pl.* 81, *fig.* 32). The remaining genera, the names alone of which we can mention, are, *Geotriton*, *Euproctus*, *Bradybates*, *Pleurodeles*, *Glossoliga*, and *Megapterna*.

The Japanese species belong chiefly to the genus *Onychodactylus*, known especially for the claws developed during the breeding season; *Cynops*, with a supra-orbitar foramen, and a skull almost precisely like that of *Notophthalmus*, but with parotid glands; and *Hynobius*. The species are but five in number.

The last form to be mentioned is the genus *Anaides* from the Island of

Maui, one of the Sandwich Islands. This genus, thus far represented by a single species, *Aneides lugubris*, has much the form and size of *Plethodon glutinosus*, but the tail is not so long. Head broader than body, tapering anteriorly. Mouth opening from behind the eyes, outline undulating as in the alligator, and the teeth of the jaws very large, compressed, and sharp, the lower the larger, and all apparently unattached to the bone, but united to the gum, and admitting of a depression backward. The sphenoidal teeth are in a single close-set patch. The tongue is large, cordiform, and attached along the median line. Its place is, perhaps, between *Plethodon* and *Desmognathus*, the peculiar ligament of the latter even appearing present.

The great interest felt by the naturalist in the order *Batrachia urodela*, has caused us to dwell more at length upon these animals than we shall upon those which succeed it in the series. The next in regular order is that of *Batrachia anoura*. As already remarked, its most conspicuous external character is the absence of a tail in the adult, and the presence of four legs, the posterior the longest. The skull is very short and broad. The lower jaw is generally without teeth, which also are never found in the sphenoid, but occur almost always in the divided vomer. The vertebral column consists of but few bones, rarely more than eight. The articulations are transversely convex behind, and vertically concave before; the spinous processes are mostly wanting; the transverse processes are well developed, and only occasionally are there rudiments of cartilaginous ribs attached. The sternum is present, sometimes cartilaginous in part, and terminates behind by a broad xiphoid cartilage. The posterior vertebræ are replaced by a long bone situated in the middle between the two parallel ilia, whose posterior portion, embracing the ischium and pubes, are combined into a vertical plate with a glenoid cavity on each side, and so close together as almost to constitute a perforation in the compressed bone: these sockets receive the heads of the tibiæ.

The structure of the tongue affords a convenient opportunity of dividing the anourous batrachians into two sub-orders, *Phaneroglossa* with a distinct tongue, and *Phrynaglossa* without a tongue; the latter embracing a very small number of species. Considering, first, the *Phaneroglossa*, we find it divisible into three families: the *Ranidæ*, with teeth in the upper jaw, and the ends of the toes simple; the *Hyladæ*, with teeth in the upper jaw, and the ends of the toes dilated into sucker-like disks; and *Bufonidæ*, with no teeth around the upper jaw.

The generic characters of the first family are derived from the varying shape of the tongue, from the greater or less extent and occasional absence of the external tympanum, and the number and arrangement of the vomerine teeth. Species of this family, as of the two others, are found in all quarters of the globe, not confined, like the *urodela*, to the more temperate regions. The true *Ranidæ* are, more or less, inhabitants of water or its vicinity, feeding on aquatic insects, and other animals, which they devour with great voracity. The flesh is much esteemed, especially that of the hind legs, and the animals are caught for the table in nets or by hooks. The

simplest and most efficacious way is to tie three large hooks back to back, and affix a piece of red flannel, at which, especially in bright, sunshiny weather, the frog will often spring with great avidity, and thus hook itself. Of the 16 genera into which this family is divided, but three are natives of North America, one of them being peculiar to it. The first genus, *Rana*, or true frog, has the large fleshy tongue divided more or less posteriorly into two cornua or branches, capable of considerable motion, and used in capturing the food of the animal, by which character it is distinguished from all the other genera. Species of this genus are quite numerous in North America, one of them, *Rana pipiens*, known as the bull-frog, attaining to an enormous size, and celebrated for the loud bellowing audible at a great distance. Individuals have been seen that measured 22 inches between the ends of the extended extremities, and even this size has been exceeded. The next largest species is the *R. fontinalis*, distinguished from the first by the presence of a fold of skin running along the side of the animal. The other species are not very conspicuous excepting the *Rana sylvatica*, or wood frog, an animal often found in damp woods among the leaves, and exciting attention by its yellowish color, and black stripe on the sides of the head passing through the eyes, as also by the extreme agility of its movements. The *R. temporaria* of Europe (*pl.* 81, *fig.* 34) is exceedingly like it, the principal difference lying in a smaller tympanum. Another European species, *R. esculenta*, is shown in *pl.* 90, *fig.* 5. This, like all the true frogs, or *Ranæ*, has a membrane between the hind toes to assist in aquatic propulsion. The number of eggs laid by the frogs is very considerable, in some cases amounting to several thousands. They are generally deposited around some aquatic plant enveloped in a gelatinous mass. When the ova are ready for exclusion, the male mounts upon the back of the female, and as the eggs are discharged ejects a small quantity of seminal fluid into the water where the operation takes place—this sometimes occupying days and even weeks, during the whole of which time the pair thus remain attached. The egg after passing through the embryonic changes appears as a larva, all head and tail, with simple entire gills which soon disappear, to be followed by others of more complicated structure, situated within the cavity of the body as in fishes. After a certain length of time the hind legs begin to appear, and still later the forelegs are found to exist, fully formed beneath the skin, ultimately to burst forth. The tail then disappears by absorption, this taking place very rapidly. A remarkable internal transformation takes place during these external changes, from the herbivorous tadpole to the carnivorous frog. The reproductive history of nearly all the *Batrachia anoura* is very similar to that just described, with special modifications, to be referred to under the proper head.

The genus *Scaphiopus*, with much of the appearance of a toad, is yet distinguished by the teeth in the upper jaw. There is a cartilaginous process on the hind foot, serving the purpose of a shovel in excavating the holes in which the animal dwells. The toes are palmated, and the tongue nearly entire. *Cystignathus* is well distinguished by the entire absence of

a web between the toes of the hinder feet. The European genus *Alytes* is remarkable for the peculiar habit exhibited by the single species with regard to its eggs. When these have been deposited by the female, the male takes possession of them, and wrapping them round his body repairs to some moist spot, where he remains patiently until they are nearly ready to become disclosed, upon which he carries them to the water, this being the proper element of the tadpoles. This habit will recall to the mind of our reader what has been said of *Desmognathus*. *Pelobates fuscus* is represented in *pl.* 81, *fig.* 38 *a b*; *Bombinator igneus*, in *fig.* 37 *a b*; both European.

The family of *Hyladæ*, known by the dilated toes, is almost entirely arboreal in its habits. While the *Ranidæ* dwell in the marshes and wet places of the earth's surface, and the *Bufonidæ* live on the drier land, the *Hyladæ* are mostly to be sought for among the thick foliage of trees, where they make the woods resound with their piping melody. They are especially abundant in the dense forests of tropical regions, where they occur of various shades of color, among which the green of the leaf and the grey of the bark predominate. In the spring of the year they betake themselves to the water for the purpose of reproduction; and the tadpole undergoes the same changes which we have described in the case of the true frogs.

The genera of *Hyladæ*, found in North America, are but two. *Hyla* is known by the semi-palmated toes with very decided disks, by means of which it can adhere with great tenacity to any surface, even that of glass The slightly emarginated tongue is round or oval. Here belong the well known tree frogs, the two best known species of which are *H. versicolor*, so similar to the European *H. viridis* (*pl.* 90, *fig.* 6, female, *pl.* 81, *fig.* 35, male), and *H. lateralis*. The species *H. pickeringii*, possibly constituting a separate genus, lays its eggs singly on submerged grass, and they develope in the very short space of three days. The remaining genus, *Acris*, has a cordiform tongue, and the dilatations of the toes are less conspicuous. The species of this genus are not arboreal, being found principally among the high grass of marshes and streams. It is among the *Bufonidæ* that we are to look for the highest development of the anourous batrachian structure. Most species are far from presenting that variety of colors, that freshness of appearance, and agility of movement, which make the frogs so conspicuous. They are not confined to the vicinity of water, but inhabit districts in which but little moisture exists, and remaining concealed during the day, emerge at night to gather up such insect food as they may chance to come across. Species of the typical genus of this family, *Bufo*, or the toad, although repulsive in their appearance, are yet perfectly harmless in themselves, and may be of great benefit to the horticulturist, in devouring large numbers of insects injurious to vegetation. A milky juice exudes from the skin of most species, secreted by special glands: this, in some species, is quite acrid, while in others it is entirely free from any such property. A striking difference is observed between the frogs and true toads, in the manner in which the ova are laid in the water. In the former they appear as amorphous, generally globular masses, enveloped in

a jelly; in the latter as two long, perfectly cylindrical cords of transparent jelly, with the eggs inclosed at regular intervals. The development of the egg takes place much as in the case of the frog, already referred to; the tadpole, however, never attains to a great size, and the transformations are completed in much less time. A difference in the amount of metamorphosis is also observed.

While the embryonic fin of the hind foot is permanent in the water-frog, and disappears but partially in the tree-frog, in the toad it vanishes entirely, leaving the hind feet cleft to the base. Of the true genus *Bufo*, with simple toes and a distinct tympanum, there are several species known in the United States, but one, however, *B. americanus*, occurring in the northern portions. A common European species, *B. viridis*, is seen in *pl.* 90, *fig.* 1. *Pl.* 81, *fig.* 36, represents a variety of this, known as *B. calamita*, with a yellow dorsal stripe. The genus *Engystoma* is also an inhabitant of the southern parts of the United States. It is distinguished from *Bufo* by the absence of a tympanum, and the rather long and slender toes. *Pl.* 90, *fig.* 2, represents a species, *E. ovale*, from South America.

As already observed, the most conspicuous character of the sub-order *Phrynaglossa* is to be found in the entire absence of a tongue: this organ existing, in greater or less development, in all the other anoura. A second character, no less important, is to be found in the fact that the Eustachian tube is single, and situated on the posterior median portion of the palate. In the others, there are two, one on each side, sometimes at a considerable distance from each other. There are but two genera included in this sub-order.

The genus *Dactelythra* is provided with teeth in the upper mandible, but not on the vomer. The Eustachian orifice is of considerable size at the posterior part of the palate. The toes are simple, four anterior and five posterior, the three first of those on the hind foot encased by their terminal extremity in a horny, thimble-like process. The single species, *D. capensis* (*pl.* 90, *fig.* 3), is a native of South Africa.

With the same ordinal characteristics as the last the genus *Pipa* is distinguished by the entire absence of teeth, the small Eustachian orifice situated nearly in the centre of the palate, and the four anterior toes, each subdivided into four small branches at the terminal extremity. The hind feet are entirely palmated. The most singular feature in the history of the single species *P. americana* (*pl.* 90, *fig.* 4) is to be found in the manner in which the eggs are developed. The eggs, as laid by the female, are placed upon her back by the male, who fertilizes them there with his seminal fluid. The eggs, adhering with great tenacity to the back of the female *Pipa*, produce a peculiar irritation, which results in the evolution of a membranous or cellular matter, which, growing round the eggs, envelopes them completely. Here they undergo all their changes from the embryo to the larva or tadpole, and thence to the perfect frog; emerging, after the lapse of about eighty days, in a fully formed and tailless state, although exceedingly minute. The *Pipa* is an inhabitant of various parts of South America, especially of Guiana and Brazil.

The third and last order of the naked *Reptilia* or *Batrachia* is to be found in the *Peromeles*, embracing but one family, the *Cœciliadæ*. Until within a comparatively recent period the species of this family were included among the *Ophidia*, on account of their serpentiform body. This, however, while cylindrical, and entirely destitute of limbs, yet has the scales so minute as to be almost entirely concealed in the folds of the skin. The anus is situated at the extremity of the body, and presents a rounded, plicated orifice, instead of a transverse slit. The most striking batrachian characters, however, are to be found in the double occipital condyle, and the existence of branchiæ in the young. The principal difference between the Cœciliadæ and the other batrachians is to be found in the entire absence of limbs and the presence of true ribs.

Of the eight known species, distributed in four genera, five are natives of America, two of Asia, and one of Africa. The most conspicuous characters of the genera are to be found in the position of the pits or false nostrils, which in *Cœcilia* are below the true nostrils, in *Siphonops* one at least before each eye, in *Epicrium* below the eyes on the lips, and in *Rhinatrema* are entirely wanting. The third of these genera is peculiar to Asia, the others are all represented by South American species. One species of *Siphonops*, *S. mexicanus*, is a native of Mexico.

Having thus finished the consideration of the living batrachian fauna, it becomes necessary to devote a small space to that of the fossil species. We have already referred to the genus *Orthophya*, as being probably one of the Proteidæ, and to *Andrias*, as occupying a station intermediate between the living *Menopoma* and *Megalobatrachus*. Three species of true Salamandrinæ are described as occurring in Central Europe, and referred to the ambiguous genus *Triton*. Among the oldest indications of *air-breathing* vertebrates are to be found certain tracks or foot-marks, from the coal measures of Westmoreland county, Pennsylvania. These decidedly salamandrine vestiges indicate an animal far exceeding in size any of its allies of the present day. Somewhat similar foot-prints have been found in various quarries of Central Europe, and ascribed to a hypothetical *Cheirotherium*. It is supposed, by some geologists, that they were made by a *Labyrinthodont*. Traces, also, of probably batrachian foot-marks are to be found in the new red sandstone of Connecticut and Massachusetts. A few of the anourous batrachia have been found fossil in France and Germany, some of them referred to the modern genus *Rana*.

Sub-class 2. Reptilia squamata.

We have already referred to the principal features of this sub-class in treating of *Reptilia* in general. It only remains for us briefly to state in what it differs from the *Reptilia nuda*, and then proceed to an illustration of the various orders and their subdivisions. This difference consists mainly in the dry horny or bony covering, as distinguished from the moist, naked skin of the *Batrachia*. Instead of a condyle on each side of the

occipital foramen, there is a single one placed below, formed either by the basi-occipital, or by this together with part of the ex-occipitals, as in the *Chelonia*. The ribs are always present, sometimes in great development and number. The vertebræ exhibit a great diversity in the shape of their articulating faces, and are generally quite complicated in structure. The entire system exhibits a higher state of development, ossification is more complete, the apparatus of sense more perfect, this being well exhibited in the tympanic apparatus. Respiration is carried on by means of lungs. The eggs are generally protected by a calcareous or toughly membranous opaque covering; and the development of the embryo is complicated by the presence of an allantois, and the amniotic sac with its peculiar liquid, the liquor amnii.

Order 2. Ophidia.

The *Ophidia*, or *Serpents*, are especially characterized among *Reptilia* by the limbs being either entirely absent, as in the majority of the species, or else being so rudimentary as to be discoverable only on dissection or very close examination. The bones of the face, excepting in a few species, possess a great deal of mobility. The lower jaw, instead of a direct articulation with the upper, is brought into connexion with it through the medium of two bones, movable on each other. The extremities of the lower jaw, also, instead of being anchylosed, are united by an extensile ligament. The mouth is variously provided with teeth, these in some species serving as a tube for the injection of a peculiar poison secreted by special glands. There are no movable eyelids, nor is there any external ear. The vertebræ are very numerous, always exceeding 100, the posterior articulation spherically convex, the anterior spherically concave. Ribs, very numerous, free. The skin is covered with scales of various shapes and proportion, an epithelium from which is shed once or several times in a year, usually in one entire piece. The tongue is soft, fleshy, bifurcated, and capable of considerable protrusion, and working in a sheath. It is never venomous, as is commonly supposed. The male organs of generation are usually concealed within the cloaca; they are bifurcated and armed with recurved spines. The protrusion of this bifurcated and thickened penis, under certain circumstances, has no doubt given rise to the vulgar idea of the possession of distinct feet by the common snakes of the United States. The transverse slit of the cloacal orifice marks the line of distinction between the body and tail. One lung of the two is more generally abortive or rudimentary.

Although destitute of limbs, the usual organs of motion, yet some serpents are capable of a very rapid progression. This progression may take place in various ways: thus the body may be straightened out entirely in contact with the ground, and a slow motion produced by the action of the scales and ribs, somewhat similar to that of the earthworm with its setæ. Again, the body may be thrown into several undulations in

a vertical plane, the posterior of which being used as a fulcrum, or *point d'appui*, the straightening of the anterior must result in the advance of the head, which in turn is fixed while the rest of the body is again flexed. The same condition may also prevail where the undulations are horizontal, and the snake constantly in contact with the ground. The most rapid movements, in all probability, are those occurring when the whole body is gathered up into one vertical loop like a bent spring, the head and tail more or less approximated: the sudden straightening of this loop or spring, with the tail as the *point d'appui*, might enable the animal to spring forward, at one operation, to a distance greater than the length of its body. The great flexibility of their bodies enables serpents to obtain access to the most varied situations, by climbing or otherwise. Many species can climb trees in search of their prey, while others live habitually in such situations. Others are as constant inhabitants of the water.

The phenomena of reproduction are different in different species. It may, perhaps, be considered as a general rule, that most of the venomous serpents are ovo-viviparous. This, however, with some appears in a measure to depend upon the latitude and mean temperature. Some harmless species, again, are ovo-viviparous, as most of the North American *Tropidonoti*. Providence has taken the usual precautions against the increase of dangerous animals by assigning a small number of young to the venomous species. Thus the rattlesnake (*Crotalus durissus*) rarely produces over nine or ten at a birth, while in one instance, 81 living garter-snakes (*Tropidonotus sirtalis*), of over nine inches in length, have been taken from a single individual.

But few species of *Ophidia* have been found in a fossil state. None from North America have been described; some of their remains have been procured in the bone caves of Pennsylvania. All that are known belong to the tertiary epoch. Remains of a species, 20 feet in length, have been found in the London clay at Sheppey. Doubtful indications of fossil *Crotali* exist in the vicinity of Brussels.

A scientific exposition of the *Ophidia*, according to their natural affinities, is a matter of considerable difficulty, as the recent discovery of numerous new species, and the obscurity which hangs over many of the old, have completely unsettled the older views on this subject. In no other department of Zoology have the views of systematists been more at variance with each other than in that of *Ophiology;* the important labors of Oppel, Fitzinger, Bonaparte, Schlegel, Gray, and others, only serving to render this truth more conspicuous. We shall, with J. E. Gray, divide the order into five families: *Crotalidæ*, *Viperidæ*, *Hydridæ*, *Boidæ*, and *Colubridæ;* the two first arranged under a sub-order *Viperina*, the remaining three under *Colubrina*.

Sub-order 1. *Viperina*.

This sub-order includes most of the species which, on account of their venomous properties, have been the terror of mankind. They are dis-

tributed over most of the world, being much more abundant, however, in tropical and sub-tropical latitudes. The first and most characteristic feature is the scarcity of small teeth in the jaws. The upper jaw presents few if any teeth on its exterior, contrasting strikingly in this respect with harmless colubrine snakes, in which the teeth, though small, are in very great numbers. This absence of prehensile instruments is more than compensated by the formidable poison fangs. These are situated in the diminutive superior maxillary bone, which is so articulated to the external pterygoid bone that when the latter is pulled back by the muscle of the jaw the maxillary is drawn back also, and its attached fangs are imbedded in the soft mucous gum, with the point directed backwards. On the other hand, a drawing forward of the pterygoid pushes up the maxillary, and the fangs then stand more or less perpendicular to the roof of the mouth. The fang itself consists of a tube, very sharp at the point, and formed by the bending over of the sides of the growing tooth, leaving a seam in front, which ultimately becomes wholly or partly obliterated. A tin tube, bent up, but not soldered, and cut off obliquely below, so as to form a cutting point, affords a good illustration of the character of the fang; or else we may imagine a solid conical tooth, flattened out and bent so as to form a hollow tube. The glands which secrete the poison are situated one on each side of the posterior part of the head, and consist of lobules which discharge the venom into the common duct continuous with the hollow of the fang. These glands are surrounded by a strong aponeurotic bag in connexion with muscles which are capable thereby of exerting a powerful compression, and of forcing out the venom with great violence into a wound.

Antidotes to the bite of venomous serpents have been anxiously sought for in all countries where such species exist. No directions applicable to all possible cases can be given, but the following indications, chiefly by Dr. Leuz, as the result of his long continued observations on the European viper, are worthy of all attention, as applicable in general to the rattle-snakes and copperheads of our own country.

No time is to be lost in obtaining assistance after being bitten by a serpent; if a pair of sharp scissors or a knife be at hand, open up the wound immediately and allow it to bleed freely, after which it is to be well washed; if the wound be a simple scratch, washing alone will, perhaps, suffice. If the bite is not to be managed in this way, endeavor to apply, as soon as possible, a powerful pressure to the wound, by laying a small pebble or other minute object directly on (not merely near) it, tying round a handkerchief, or using the finger, to keep up a direct pressure on the spot, and continuing this application until the place affected can be conveniently cut out, or cupping-glasses applied. As long as the direct pressure lasts there will be no absorption of the poison, and if no other application be possible the thumb may be kept upon the wound until help can be obtained. The puncture of the wound may sometimes be reached by the mouth of the patient or a companion, in which case prompt suction of the spot may render further remedies unnecessary. This may be done by the

operator with impunity if the mouth be sound, as the virulence of the poison is only manifested when introduced into the circulation; repeated experiment has shown that a moderate amount may be taken into the stomach without danger. A well fitted syringe, with rather a long nozzle, is often used to great advantage in sucking out the poison, the same purpose also being answered by cupping instruments. If none of these methods can be employed, and the venom has become absorbed, then attention must be turned towards the proper internal remedies, those merely external being of no further avail. The wound is to be carefully bathed with chlorinated water, or with water to which has been added some chloride of lime, and the patient put to bed. Of the internal appliances now to be made we have our choice of two kinds: the first consists in employing some sudorific, by which a copious perspiration may be brought about; this, though not always successful, is yet almost always advisable. The second remedy is chlorine, which is to be used instead of the sudorific; this may be in the form of chlorinated water, or of the chloride of lime dissolved in water.

It is almost needless to add that many of the applications to a serpent bite, such as a chicken stripped of its feathers, &c., depend almost entirely for their efficacy upon the controlling influence of a powerful faith, and the same may likewise be said of many of the vegetable remedies. The mucilaginous juices of plants in general appear to exert a controlling influence upon the result, although some species, as *Impatiens pallida* and *fulva* (glassweed), *Eupatorium perfoliatum* (boneset), *Plantago major* (plantain), and others, appear to have specific influence. The use of alcoholic liquors, as brandy, in large doses, has been recommended by some members of the Faculty. Ammonia, or spirits of hartshorn, olive oil, and many other substances, to be applied both externally and internally, have all had their supporters. Generally speaking, however, the only sure remedy lies in the immediate removal of the poison by suction, washing, increased flow of blood, excision of the part, &c.

We have thus gone into some detail on the subject, believing it to be of intrinsic importance in a country abounding in venomous serpents, to be aware of what may be done to arrest the progress of an affliction, which, if not always mortal, is yet productive of a great deal of pain, and often chronic affections of the system.

We proceed to enumerate in brief terms the remaining characters of the sub-order *Viperina*. The lower jaw is provided with teeth as in the *Colubrina*. The head is usually broad, so as to exhibit a very strongly marked distinction between it and the neck. The crown is generally covered with scales much like those of the back, rarely with shields or plates. The hinder limbs are not present even in a rudimentary condition. The eyes are on the side of the head, often shaded by an overhanging brow; the nostrils are placed at the side of the snout, near the tip. The two families, included in the sub-order, are distinguished by the presence or absence of a pit or depression between the eye and the nostril.

Fam. Crotalidæ. Face with a large pit on each side. The head is

large behind, with a flat crown, which is covered by scales (except in one or two genera, which have plates). The belly is covered by broad band-like shields, and there are no spurs or rudimentary feet on each side of the anus. The species are all more or less venomous, and generally ovo-viviparous.

The genus *Crotalus*, or rattlesnake, forms the type of this family, and its species are distinguished from all the rest by the presence of a rattle at the end of the tail. This consists of several joints of a horny texture loosely united together, so that when quickly vibrated a noise is produced much like that of peas shaken about in a dried bladder, and bearing a considerable resemblance to the sound produced by the locust or cicada. There are two or three species of the restricted genus *Crotalus* in North America: one the *C. durissus*, another the *C. adamanteus*. The former is abundantly distributed throughout the United States, although limited in northern extent, and rarely found north of the parallel of 45°; it is especially common in the Alleghany region of the United States, where its habits are familiar to every resident. It is a sluggish animal, and not disposed to act on the offensive, so that a person may pass within a few feet of it without being molested. An approximation of that kind is generally followed by an alarm from the snake, which most usually precedes any blow. The animal never strikes except when coiled, and rarely, if ever, follows a retreating enemy. Its food consists of small animals, rabbits, squirrels, rats, birds, &c., all of which are speedily destroyed by a single blow. Even dogs are sometimes killed by them, although larger animals are not generally destroyed. The immense *Crotalus adamanteus*, or diamond rattlesnake of the Southern States, is vastly more formidable. This species appears restricted to the southern coast below the latitude of North Carolina, and has been known to exceed eight feet in length, with a thickness equal to that of a stout man's leg. They keep much about the water, and have hence been called the water-rattle, in distinction from the preceding species, which affects high dry land. A third species, common in South America, is *C. horridus*, sometimes called *Cascavella*, and represented in *pl.* 87, *fig.* 5. There are also several small species in North America belonging to an allied genus *Crotalophorus*, and usually termed ground rattlesnakes. These have the head covered with plates, and the rattles very small, even in individuals of considerable size. One of the species, called the *Massasauga*, occurs in Northern Ohio, others in the Southern States, and in the region west of the Mississippi.

The copperheads (genus *Trigonocephalus*) of America are, if possible, more dreaded than even the rattlesnakes, owing to the fact that, with equal venom, they are more vindictive and give no warning of their presence. The most generally distributed species, *T. contortrix*, is fond of damp meadows, where it is often revealed to the cost of persons engaged in mowing or passing through. They not unfrequently get into cellars, where they perform an acceptable service in destroying mice and rats. The water-moccasin of the Southern States (*T. piscivorus*) is the pest of rice plantations, where negroes are often bitten. This species lives in the

water, much like the harmless water-snakes of the Middle States, and like them may frequently be observed lying over bushes which overhang the water, into which they plunge at the slightest alarm. Another species, *T. lanceolatus*, or the *fer de lance* (*pl.* 86, *fig.* 3), is abundantly distributed through several of the West India Islands, where it inhabits all kinds of situations. Their favorite resort is the sugar plantations, where they prove fatal in many instances to the unlucky laborers.

All the poisonous serpents of North America have been referred to in the preceding remarks, and none except the rattlesnakes, copperheads, and water-moccasins, are to be feared in the slightest degree. The last mentioned species does not occur north of Virginia, nor does the *Crotalus adamanteus*, so that in the whole Middle and Northern States there are but two venomous species, the banded rattlesnake and the copperhead, both of which are readily recognisable. Nothing can be more ridiculous than a fear of the common watersnakes, greensnakes, blacksnakes, gartersnakes, housesnakes, and other species. It is true that many of these show fight when attacked, and many even inflict a wound with their teeth, though this can never be more than a scratch which may draw blood freely, but will not produce any more unpleasant consequences than the scratch of a pin or of the point of a knife. The same may be said of the blowing or hissing snakes of the genus *Heterodon*, usually termed viper or adder in the United States, and which present a formidable appearance from flattening the head and whole body when irritated.

The family *Viperidæ*, with the poisonous apparatus, as the *Crotalidæ*, is distinguished by the absence of the pit or depression on each side of the face. Of the 20 species and 9 genera of this family, none are found in America. The most conspicuous and typical species is the viper of Europe, *Vipera berus* (*pl.* 87, *fig.* 2), which is pretty generally distributed and greatly feared, although far from being so formidable as the copperheads and rattlesnakes of the United States. Great pains are taken to destroy the species, although ineffectually, owing to their rapid reproduction ; in Gotha, Coburg, and Meiningen, a stated price per head is paid for them by the civil authorities. The famed *Aspic* or asp of antiquity is another species of viper (*V. aspis*) found along the Mediterranean. The horned-viper (*Cerastes cornutus*, *pl.* 87, *fig.* 3) is a common inhabitant of the sandy desert of Africa, and is remarkable for having a group of elevated horn-like scales over each eye.

The celebrated *Cobra di capello*, or hooded-snake (*Naia tripudians*, *pl.* 86, *fig.* 4), is a species which has been variously allotted by herpetologists, and even placed among the Colubrine snakes. It is an inhabitant of the East Indies, where it is often tamed by jugglers and taught to dance to their rude music. This class of persons appear capable of exercising some peculiar influence over the cobras, by means of which they are enabled to handle them with impunity. Another genus, of which one East India species, *Platurus laticaudatus*, is figured in *pl.* 90, *fig.* 8, has been referred to the *Colubridæ*. It lives in the water, and is very dangerous to bathers.

Sub-order 2. Colubrina.

In the *Colubrina* we miss the highly developed poison fangs which are so conspicuous in the *Viperina;* and the upper maxillary bones, or edges of the jaw, are well supplied with teeth. Some few of the species, however, are poisonous, this being especially the case with the *Hydridæ*, or water-snakes, of the East Indies. Their venom fangs, however, are small, and there are several teeth in a line behind the fangs. The head is of moderate size, not conspicuously wider than the neck, and the crown in one family is covered by a regular shield. Of the three families of the sub-order, *Hydridæ, Boidæ*, and *Colubridæ*, the two first have the belly covered with small, narrow, elongated scales, like those of the back; while in the *Colubridæ* the belly is covered with large, broad plates, each one extending entirely across the abdominal surface.

Fam. Hydridæ. This family, the species of which live almost altogether in the water of seas, lakes, and rivers, are distinguished from the *Boidæ*, with which they agree in the small scales on the belly, by the entire absence of spurs on each side of the anus, like rudimentary feet. The ventral scales are narrow, hexagonal, or bandlike; the eyes and nostrils look upwards, the latter generally placed in the middle of a shield with a slit or groove to its outer edge; the fangs are of moderate size, intermixed with the maxillary teeth; the pupil is small and round, and the tail is usually compressed into an oar, but sometimes conical. Very many are poisonous. The species with compressed tails belonging to *Pelamis, Lapemis, Hydrus*, &c., are true snakes, coiling themselves up on the shore, where they lay their eggs. Their food is said to consist of seaweeds, although perhaps incorrectly. They are often found asleep on the surface of the sea, and are then easily caught, as they cannot descend without first throwing themselves on their backs, probably to expel the air from their large vesicular lungs. They are often thrown ashore by the surf, and are occasionally found in fresh water, having been brought in by the tide, but they appear unable to live long out of salt water. The fishermen of the Eastern seas often catch them in their nets, and hold them in great dread on account of the venom of their bite. The species with conical tails appear to live principally in fresh waters. Some recent authors have placed North American species under this family, though apparently with much impropriety (*Helicops abacurus*, and *erythrogrammus* of Holbrook, with some others). *Pl.* 90, *fig.* 7, represents *Achrochordus javanica*, a species of this family from Java.

Fam. Boidæ. In this family, which contains species not poisonous, indeed, but terrific on account of their gigantic size, we find the ventral scales or shields to be narrow, transverse, and often six-sided. The hinder limbs are developed under the skin, formed of several bones, and ending in a short exserted spur, placed one on each side by the vent. The tail is short, generally prehensile, and the pupil is oblong and erect, except in the genus *Tortrix*.

One of the best known species of *Boidæ* is the anaconda (*Eunectes murinus*, *pl.* 74, *fig.* 62). It is found in Brazil, and is said to attain to a length of 40 feet, although the specimens exhibited in museums and menageries rarely exceed 10 or 15. In a wild state it is often found with the tail coiled round a tree on the river's edge, and the body floating in the water, thus awaiting the approach of its prey. It feeds on animals of moderate size, peccaries, agoutis, &c., which it kills by crushing, and then swallows whole, but does not disdain fish, frogs, &c. Little fear is experienced by the inhabitants of the country, as it is quite timorous and rarely disposed to attack man.

The *Boa Constrictor* (*pl.* 86, *fig.* 5) is another familiar species from Brazil; it is more terrestrial in its habits than the anaconda, keeping in dry desert situations, among bushes, trees, and rocks. It readily climbs trees, from which it hangs suspended by its prehensile tail, ready to drop upon any unlucky animal which may pass beneath. Like the anaconda, it is destroyed in various ways, by shooting, lassoing, noosing, &c. The thick skin is frequently tanned and converted into leather for boots and saddles. The fat is made use of for various fanciful purposes, and the dried excrement employed as medicine. Another species, *Boa*, or rather *Xiphosoma caninum*, from Brazil, is represented in *pl.* 87, *fig.* 4. The giant snakes of the Old World belong chiefly to the genus *Python.*

Fam. Colubridæ. In this, the last family of *Ophidia*, we find species which are very rarely provided with poisonous fangs. The belly is covered with broad scales, and there are no rudiments of hind feet as in the last family. The tail is conical and tapering, and rarely compressed. The nostrils are open and placed at the side of the snout, near the top. The head is most generally covered with regular plates, which by their number and shape afford excellent distinctive characters. They are distributed all over the world, and are in much greater number, both of individuals and species, than in any other family of *Ophidia.*

This family is especially abundant in the United States, where it occurs under two principal types, *Coluber* and *Tropidonotus*, with several sections of less extent. The genus *Coluber* embraces most of the larger familiar species with the scales smooth and without a longitudinal ridge along the centre of each, as in *Tropidonotus.* The body is generally slender and cylindrical, and incapable of being flattened in a horizontal plane like *Tropidonotus.* They are rarely seen in the water, and are mostly oviparous, the eggs being deposited in decayed wood, sand, or other localities. The other genus, *Tropidonotus*, on the other hand, possesses the power of depressing the body, and is generally viviparous, the eggs being developed in the oviduct. *Coluber constrictor*, or the Black Snake, is a familiar instance of the American species of *Coluber.* It is abundant in all parts of the country, and sometimes attains the length of six feet. It climbs trees with great readiness, and moves over the ground with much velocity. Numerous stories are current of their pursuing individuals, and thereby earning their common name of "Racers." It is quite possible that under some circumstances they may follow after a person who flies in terror

before them, but such is not the experience of herpetologists, with whom the case is exactly reversed; the snake here being usually the fugitive, and too often escaping by his superior agility, thus also eluding the just claims of science to his body.

The agility with which the black snake can climb trees renders it a formidable enemy to young birds and squirrels in their nests. The fabled fascination exerted by the serpent in all probability has reference to the distress occasioned by his vicinity to a bird with a brood of young, the whole of which are sometimes devoured at a meal. It is needless to add, after what has already been said on the subject, that the black snakes, and all other colubrine snakes of North America, are perfectly harmless. A closely allied black species, called *Coluber alleghaniensis*, attains to a much larger size than the *Constrictor*, individuals of 7 and 8 feet not being very rare. This is much more gentle than the other, rarely manifesting any inclination to bite, which the more common true black snake is very apt to do. The black snakes, as well as some other large colubrine species, often engage in deadly battle with the rattlesnakes, and, strange to say, usually come off victorious, owing to their superior agility, and the quickness with which they evade the poison thrusts of their antagonists, and secure an opportunity of squeezing them to death.

The type of the genus *Tropidonotus* is found in the familiar garter snake, *T. sirtalis*, the most abundant species in this country. Like all of its genus, it is frequently found about the water, but as often on high dry land. Its fecundity is very great, as in one instance eighty-one young, of over nine inches in length each, were taken from a single female. The water snake of the Middle States (*T. sipedon*) is a species sometimes called moccasin, and wrongly dreaded as venomous, on account of its supposed identity with the species of the lowlands of Georgia. Other species are, *T. leberis*, *dekayi*, &c. *Pl.* 86, *fig.* 2, represents the European *T. natrix*.

We shall conclude this subject by a brief consideration of some other American species with that of an interesting African genus. In addition to the colubrines already enumerated, there is the beautiful *Coluber vernalis*, or green snake, found rather abundantly in the Northern and more rarely in the Middle States. In the South it is replaced by the beautiful green *Leptophis æstivus*. A long, slender, exceedingly swift species of the Southern States (*Psammophis flagelliformis*) is called the whip snake. The diamond or ring snake, *Coronella sayi*, is conspicuous for its minute white specks scattered all over a black ground. It is one of the species most frequently engaged in successful conflict with the rattlesnake. *Elaps fulvus* is a beautiful species, variegated with rings of red, black, and yellow, known in its abode, the Southern States, as the harlequin or scarlet snake. It has one large immovable fang on each side of the upper jaw, which is perhaps provided with a rudimentary poison gland, but the animal is considered to be perfectly harmless. A South American species (*E. corallinus*) of equal beauty and harmlessness, is represented in *pl.* 90, *fig.* 9. The *Heterodons* have already been referred to under the name of adder or viper. Of two large and common species, *H. niger* and *platyrhinus*, known as black and

yellow vipers, neither is poisonous, nor even in the slightest degree noxious, although of quite terrific appearance and demeanor when enraged.

An exceedingly interesting illustration of the special provision which nature sometimes makes for particular cases is seen in the African genus Deirodon. To this has been imputed the instinct of living almost entirely on the eggs of birds, and its whole organization fits it expressly for this end. The mouth is entirely without teeth, at least in the adult, so that nothing interferes to prevent the ready entrance of an egg into the open jaw, and there is no liability of its losing any of the contents by a premature breakage. The inferior spinous processes of the seven or eight inferior cervical vertebræ project with the œsophagus, where they are capped by a layer of hard cement and made to resemble long sharp teeth. The descending eggs press against these teeth and are sawed open longitudinally, and then, crushed by the contractions of the gullet, are carried into the stomach, where the shell is probably dissolved by the gastric juice and digested with the contents.

Order 3. Sauria.

The third order of Reptiles, the Sauria or Lizards, embraces species of very diversified character, especially when we take into consideration certain fossil forms. Their size, too, varies from that of a few inches to 30 feet, as in some recent crocodiles. This magnitude, however, is far exceeded by certain extinct species. The body is generally cylindrical, sometimes slightly depressed, elongated, and with a skin provided with scales (*photides*), granulations, or bony plates. The photides they share with the *Ophidia*, and the two orders are thus distinguishable from *Batrachia*, only a single family of which, the *Cœciliadæ*, has minute cycloidal, fish-like scales, nearly concealed in the folds of the skin. By the four feet they are distinguishable from serpents, although, in a few instances, these members are partly or entirely wanting externally. The feet, when present, are usually provided with true claws, supported on the terminal phalanges. The tail is developed to a greater or less extent, while the cloaca presents itself externally as a transverse slit. The almost universal presence of an external meatus auditorius, or at least of a tympanum (excepting in Acontias, Typhline, and a few others), distinguishes the Sauria from the Ophidia; as also the presence of a sternum, connected with the vertebral column by movable ribs, and the greater immobility of the bones of the head. The rami of the lower jaw are firmly united together, and the entire skull is compact. Few Sauria are without movable eyelids, although these are occasionally very rudimentary. The teeth are variously disposed, as will be seen when we come to consider the different families. Many species are only known to us in a fossil state, these generally of great size.

Fam. 1. *Scincidæ.* This family, standing at the foot of the great order of Saurians, is characterized, in the first place, by the possession of large plates on the top of the head, which are in contact along the edges; and by their angular and regular shapes, closely resemble the homologous plates of

serpents. By this character the *Scincidæ* are distinguishable from the other Saurians, excepting the *Chalcididæ* and *Lacertidæ*. The rest of the body is covered by imbricated and smooth scales, with rounded margins arranged in quincunx, much as in fishes: those of the belly and sides are nearly of the same shape and size as those of the back. By this latter feature they are distinguishable from the *Lacertidæ*, in which the ventral scales are much larger than the dorsal, with the outlines angular. The absence of a furrow or lateral fold of skin, extending along the flanks, as also the imbricated or mailed scales, separates them from the *Chalcididæ*. The spines and crests of other Saurians are never found in this family. The tongue is free, broad, not playing in a sheath, and slightly emarginate anteriorly. It is fleshy, and usually covered with papillæ; sometimes with scales, or filiform appendages.

The *Scincidæ* are variously distributed throughout the world. The largest number of species is found in Australia, then Asia, next Africa, and finally America. Europe counts but six species. Five species are found in the United States.

The family may conveniently be divided into three sub-families, according to certain peculiarities about the eyes.

Sub. Fam. Saurophthalmoi. This section is known by the possession of movable eyelids, which, as in most air-breathing vertebrata, can come together so as completely to cover the eye. Most of the species are provided with four feet; some, however, have but two, while others again appear to be entirely deprived of these appendages. None of them appear to have inguinal or femoral pores. The lowest form of the Saurophthalmian Scinks is presented in the genus *Acontias*, but one species of which, *A. meleagris*, a native of South Africa, is known to naturalists. With a striking resemblance to a serpent, in the absence of feet and of a tympanic orifice, it has most of the characters of the Scincidæ. The eyes are very minute, and there is but a single (inferior) eyelid. Another genus, *Ophiomorus*, resembling the last, is found in Southern Europe. The best known representative of the apodal scinks is the blind or slow worm, *Anguis fragilis* (*pl.* 74, *fig.* 63, and *pl.* 87, *fig.* 1). This beautiful animal is found in various parts of Europe, making its appearance early in the spring, and retiring to winter quarters about October. Its food consists principally of slugs and earth-worms. About the end of August the female lays 8 to 16 eggs, from which the young escape very shortly after their deposit, development having proceeded for a considerable time in the oviduct. The animal is perfectly innocuous, and never makes any attempt to bite.

In the genera *Ophiodes*, *Soridia*, and *Scelotes*, we have the first external indications of feet, in the form of two feeble posterior extremities, which exhibit a division into toes in the latter genus only. The first of these is South American, the two last South African.

Anterior extremities first present themselves in the genus *Evesia*, where, however, with the hind feet, they exist as mere stumps without any toes. In *Nessia*, each foot, although still very rudimentary, is terminated by three nearly equal toes, provided with claws. *Brachystopus*, a South African

reptile, has the anterior feet without toes, the posterior with two each. This case is exactly reversed in the genus *Brachymeles*, where the anterior feet have two toes, the posterior none. In the Australian *Chelomeles*, each foot has two toes; while *Heteromeles* (from Algiers) has two toes on the fore, and three on the hind feet. *Seps*, represented by a single species, *S. chalcides* (*pl.* 87, *fig.* 6), a native of Southern Europe, exhibits three toes on each, rather weak, foot. In *Tetradactylus* we find four toes on each foot; in *Campsodactylus*, five toes in front, and four behind; and in *Heteropus*, four in front, and five behind. Finally, *Trachysaurus* and *Gongylus* have five toes to each foot. The above illustrations, far from embracing the whole of the *Scincidæ*, may serve as an indication of the great variety of structure and appearance, presented by this extensive family.

To us, the most interesting genera of Saurophthalmian scinks are *Plestiodon* and *Lygosoma*, these being the only ones which are found in the United States. The species, of various size, are known in the Southern States, indiscriminately, as scorpions, and dreaded as venomous. They are, however, like all reptiles, excepting a few serpents, perfectly free from any such properties, although the larger individuals may be capable of inflicting a severe bite. Only one species, *Plestiodon fasciatus*, is found in the North, the rest rarely occurring north of Maryland. The largest species, *P. americanus*, sometimes attains a length of 25 inches. The smaller species are usually found about old logs, their food consisting of minute insects. *Plestiodon aldrovandii*, an Egyptian species, is represented in *pl.* 81, *fig.* 31. The genus *Scincus*, as at present restricted, embraces but a single species, *S. officinalis* (*pl.* 89, *fig.* 4). This animal, a native of Northern Africa, has been celebrated from the time of Pliny, for certain supposed medicinal virtues, for which reason it was long considered as one of the most valuable articles of the pharmacopœia, and even now is kept by the druggists of Southern Europe. It was supposed to be effectual in all eruptive diseases, but the chief application was as an aphrodisiac. *Gongylus ocellatus* (*pl.* 74, *fig.* 71) is a common European reptile.

The second sub-family of *Scincidæ* is that of the *Ophiophthalmoi*, in which the eyes, like those of serpents, are either entirely deprived of eyelids, or else have these in the form of a narrow ring, partly or entirely surrounding the eye. Two of the species exhibit a series of pores along the anterior margin of the cloaca; none, however, have femoral pores. Most of the species are natives of New Holland. The genus *Hysteropus*, with a highly serpentiform body, is without fore-feet, the posterior being very feeble, and flattened, without any division into fingers. (*H. novæ hollandiæ* is represented in *pl.* 74, *fig.* 68.) Other genera have four feet, variously provided with toes.

The third and last sub-family, the *Typhlophthalmoi*, comprises species which are perfectly blind, having the eyes so minute as to be entirely rudimentary. There are but two species known, one, *Dibamus novæ-guineæ*, with posterior remiform feet, the other, *Typhline cuvierii*, an inhabitant of South Africa, without any feet whatever.

Fam. 2. *Chalcididæ.* This family, with a striking resemblance in external form to some members of the last, is readily distinguishable, as already remarked, by the different disposition of the scales, or the markings of the skin, and by the lateral furrow found in many species. We find some species provided with four legs, others with but two; while another series, again, is entirely serpentiform in appearance, owing to the absence of these members exterior to the skin. There is rarely any constriction posterior to the head, answering to a neck, the body and head being usually continuous. The scales, instead of being imbricated or arranged like those of most fishes, are disposed in whorls or rings inclosing the body. In other cases, where the scales (photides) are absent, furrows in the indurated skin present similar markings. The dorsal and ventral scales, like those of the *Scincidæ*, and unlike what we shall find to be the case in the *Lacertidæ*, are arranged much in the same manner, and are of no striking difference in size. The teeth are not implanted in the jaws, but applied along the inner margin, thus exhibiting the true pleurodont character. The tongue is free, slightly extensible, broad, and emarginate at the tip, clothed with filiform or scaly papillæ, and not plying in a sheath. The ears are apparent externally in some species, while in others there are no such indications of them. The eyes are generally small, and slightly developed. Some species have movable eyelids; in others these organs are not movable; while in a few the skin covers the entire ball of the eye.

This family is confined mainly to Africa and America, although a few species are found in other regions of the globe. Mexico, California, and the southern United States contain quite a number of them. The entire number of species described amounts to about 50, arranged in 16 genera.

We distinguish the *Chalcididæ* into two sub-families, according as the skin is covered with scales or is free from these appendages. The first sub-family, that of the *Ptychopleures*, possesses true scales arranged in the manner already described. All the species, with a few exceptions, have a longitudinal furrow, more or less deep, on each side; and, without any exception, are in the possession of eyelids. Some species possess an external auditory cavity, others are without one. The first genus to be mentioned is *Ophiosaurus* (*pl.* 74, *fig.* 63), an inhabitant of North America, and known as the "glass snake." This animal, although usually considered as a serpent, may readily be distinguished by the compact skull and non-dilatable mouth, the fleshy tongue, the external auditory cavity, and the peculiar distribution of the scales. The name is derived from the fact that a slight blow is sufficient to produce a fracture of the very brittle body, the muscles of which, instead of the longitudinal arrangement of the serpents, have the arrangement in hollow cones so conspicuous in the equally brittle tails of lizards. It is a common, although entirely erroneous opinion, that the pieces of a broken glass snake will reunite after a time. Two species are known in the United States, one, *O. ventralis*, restricted to the Southern or South Eastern States, the other, *O. lineatus*, occurring in the South West, and as far north as Michigan.

In the genus *Pseudopus*, a native of Eastern Europe and of Africa, we

have indications of a posterior pair of extremities, in the form of scaly, undivided appendages, one on each side of the anus. The single species is known in Russia as the sheltopusik. The genus *Chalcides*, whose species are mainly South American, has both pairs of extremities, but in a rudimentary state. The anterior pair terminates in three or four scaly tubercles, while the posterior is represented by two slender spines. By the absence of an external auditory cavity, it is distinguished from *Chamæsaurus*, in which none of the rudimentary extremities exhibit any subdivision. The genus *Saurophis* introduces us to the species having more highly developed extremities. Here each foot has four toes. The single species known, *S. tetradactyla* (*pl.* 74, *fig.* 67), inhabits the southern portions of Africa. The remaining genera have five toes on each foot; the most interesting of these is the genus *Gerrhonotus*, which, represented by eight species, inhabits Mexico and California.

The second sub-family, that of the *Glyptodermes*, corresponds very nearly to the family Amphisbænidæ of some authors. Here the body is entirely deprived of scales, in place of which the skin is divided by circular and longitudinal furrows into small quadrilateral compartments, sometimes variously colored, and then resembling mosaic work. These subdivisions are generally slightly tubercular and projecting. There are faint indications of the lateral furrow of the more typical *Chalcididæ*. Most of the species bear a striking resemblance to the *Ophidia*, with which they have usually been classed; they may, however, be distinguished by the entirely saurian skull, with the symphisis of the two halves of the lower jaw; by the saurian tongue; and by the fact that the vertebræ are united by fibro-cartilage. In one of the ophioid genera, *Trogonophis*, the teeth are acrodont, or attached on the cutting edge of the jaws, while in all the rest they are pleurodont, or applied along the inner edge. The genus *Amphisbæna*, or double walkers, are so called from the close resemblance between the anterior and posterior extremities of the membranous body. They appear as if possessing a head at each end, and are hence supposed to be capable of progression in either direction. They are often found in the nest of the termites, where they feed upon the young ants. The genus *Chirotes* presents the remarkable anomaly among saurians of having two fore feet, each with five fingers. In the absence of hind feet, the anterior being present, we see a strong resemblance to the batrachian genus *Siren*. The presence of a sternum further distinguishes *Chirotes* from *Amphisbæna*. The single species, *Chirotes canaliculatus*, is found in various parts of Mexico, extending northwards along the eastern base of the Rocky Mountains.

Fam. 3. *Lacertidæ*. Species of this family have a cylindrical elongated body, with the tail sometimes of very great length, and always well developed. The feet are four in number, with four or five distinct toes of unequal length, all provided with curved claws. The head is in the shape of a truncated four-sided pyramid, depressed, and covered with polygonal symmetrical plates. The typanum is distinct, sometimes externally apparent. Eyes usually with three movable eyelids. The mouth is deeply cleft, and

provided with large labial and submaxillary scales. The teeth are variously shaped and arranged, generally, however, inserted on the internal margin of a common maxillary groove. Sometimes they are found in the palate. The tongue is free, fleshy, flat, more or less extensible, the base sometimes contained in a sheath, the apex always emarginate, sometimes deeply cleft. The tail is very long and conical, the scales arranged in regular rings or whorls. The skin is scaly, without projecting crests; the dorsal scales variable; the central plates always larger, rectangular or rounded. Most of the species exhibit femoral pores.

The *Lacertidæ*, like several other families of *Sauria*, are extensively distributed. About one third of the entire number of species belongs to America; only one, however, is found to North America. Somewhat the largest proportion occurs in Africa; Europe comes next in point of numbers. About 70 species in all are known to naturalists. Some occur in a fossil state, but, for the sake of greater convenience, we shall refer to all of the lacertoid species when we come to consider the *Varanidæ*.

The *Lacertidæ* may be conveniently divided into two sub-families, the *Pleodontes* and the *Cœlodontes*. In the *Pleodontes*, the teeth are entirely solid, without any internal cavity; and attached by the bases and external faces to the inside of the maxillary bones. They are usually bent a little outwards, especially those more anterior. All the species of pleodont lizards belong to the New World. There are two strongly marked divisions of the sub-family; the one with the tail compressed, the other with it conical. Those with compressed tails exhibit a striking resemblance to the crocodiles, which is not diminished by their great size. The tail, flattened like an oar, and with the surface increased still more by caudal crests, enables these animals to move with great readiness in the water, which they inhabit to as great an extent as the crocodiles. Their feet, like those of these latter animals, are palmated. The Tupinambis of some writers is the *Crocodilurus lacertinus*, a gigantic species nearly six feet in length, inhabiting the waters of Brazil and Guiana. *Thorictes dracæna*, found in Guiana, is still larger, individuals of almost seven feet in length being known. Here the tail alone occupied nearly five feet.

The section of *Pleodonts*, embracing species with conical tails, is more extensive than the last. Here the animals are more terrestrial or arboreal. A single genus, *Aporomera*, is entirely destitute of femoral pores. *Acrantus*, a large South American genus, has but four toes visible on the hinder feet. The other forms represent no remarkable deviation from the usual structure. The genus *Salvator* (*pl.* 74, *fig.* 80) includes the true *Tupinambis* or *Sauvegardes*. Individuals of eight feet in length are not uncommon. The genus *Cnemidophorus* is interesting as containing the only representative of the Lacertidæ in North America. This species (*C. sex-lineatus*) occurs abundantly in the Southern States, and as far north as north-eastern Maryland. It is readily distinguishable from the other lizards by the six yellow lines along the back, and the long tail. When pursued, it runs with incredible swiftness, climbing trees with great facility, but not leaping from branch to branch, like the green lizard, *Anolis carolinensis*.

The second sub-family, the *Cœlodontes*, embraces species whose teeth possess an internal cavity, and are applied vertically against the inner wall of the maxillary bones, their bases, however, never being in intimate union with the bottom of the maxillary groove. All are natives of the old world, some living entirely in a sandy desert, or places where their rapid motions are facilitated by a fringe of scales to the feet, preventing them from sinking in the sand; others, again, with smooth feet, live on trees, or play habitually along walls and rocks. None are aquatic. Thetypical genus *Lacerta* (*pl.* 74, *fig.* 79), widely spread in Europe and Africa, contains species eminent for the quickness and beauty of their movements, as well as for their brilliant colors. *L. viridis* (*pl.* 89, *fig.* 7), is a species abundant on the continent of Europe, but not found in Great Britain.

Fam. 4. *Iguanidæ.* This extensive family is well distinguished from the three already considered, by the absence of large polygonal plates on the top of the head. The body is furnished with scales, which are never arranged in whorled rings, nor occur on the belly as large square plates. Most usually the back or tail is provided with a crest, and there is a general tendency to a greater or less degree of roughness externally. The teeth vary in their mode of attachment, but are never implanted in sockets or rhizodont. The moderate tongue is free at the extremity only: it is thick, spongy, or villous, never cylindrical, nor playing in a sheath. The eyes are provided with movable pupils; and the fingers are free, distinct, and all provided with claws.

Of the entire number of species belonging to this family, two thirds (about 100) are natives of America. Of these, North America possesses a considerable number, only three, however, being found within the limits of the United States. The rest are found in Asia, Africa, and Australia; a single species only occurs in Southern Europe. Some of the *Iguanidæ*, South American species especially, attain to a large size, and constitute a favorite article of food. This is especially the case in the vegetable-eating species. The eggs, too, of several are considered to be a great delicacy.

All the American species of *Iguanidæ* belong to one sub-family, that of the *Pleurodontes*, distinguished from the natives of the old world, the *Acrodontes*, in having the teeth applied along the internal margin of a furrow excavated in the mandibles. These teeth, which are very close to each other, diminish in height as they approach the extremity of the jaws. The summits of the maxillary teeth are usually more or less trilobed; in a few species the edges are denticulated; nearly all have one or two ranges of palatine teeth on each side. All possess an external auditory apparatus. Some have the toes dilated, as in the *Geckotidæ*.

Of the numerous genera (upwards of 50) into which the family *Iguanidæ* is divided, our space will permit us to mention only a few. The first that comes under our review is the genus *Anolis* (*pl.* 74, *fig.* 69), distinguished by a dilation of the skin of the penultimate joint of the toes; by the presence of palatine teeth; by the minute scales; and by the absence of pores on the thighs. Of numerous species, but one is found in the United States. This

one, *A. carolinensis*, is very abundant in the United States, where it is known as the green lizard or chameleon. It is an exceedingly beautiful animal, of a light golden green above, and greenish white beneath; the gular pouch, when inflated with air, is of a vermilion color. It keeps about gardens, and frequently enters the windows of houses in search of flies; climbs trees with ease, and is even capable of walking over glass by means of the disks of the toes. *Basiliscus* (*pl.* 74, *fig.* 74) exhibits curious appendages in the form of a vertical fold of skin on the occiput, and a high crest on the back and tail, which, in the male, is supported by osseous appendages. The absence of femoral pores, and the palatine teeth, distinguish it from other genera with crests. Of the two species known, both inhabiting Mexico and the regions south, one (*B. mitratus*) is represented in *pl.* 89, *fig.* 5. *Amblyrhynchus* is an anomalous genus first detected in the Gallapagos Islands. This volcanic group, so remarkable for its peculiar fauna, is said to contain two species of the genus: one terrestrial and burrowing under ground, the other living in salt water and feeding on seaweeds. The genus *Iguana* (*pl.* 74, *fig.* 75) is distinguished by the long flap or fold of skin under the throat; two series of palatine teeth; the long compressed tail, and the dentated crest along the back. A well known species, inhabiting South America, is the *Iguana tuberculata* (*pl.* 89, *fig.* 6). The genus *Tropidolepis*, with ten species, is interesting on account of being confined to North America. Only one species, however, comes within the limits of the Atlantic States, the rest belonging to Mexico and California. The species just referred to, *T. undulatus*, is the common grey or brown lizard, seen so commonly running along fences or among trees, especially in hilly or sandy districts abounding in pine trees. The males have an azure blue cross on the belly. There are no crests or other appendages in this genus, only a roughness of the scales. The pine or fence lizard, as it is sometimes called, is entirely inoffensive. The closely allied genus *Phrynosoma* is also North American. Several species inhabit the sandy or sterile plains of Texas, Mexico, and California. The short, squat, nearly orbicular body, the weak limbs, the long spines fringing the occiput, and the shorter ones scattered over the back, give the animal quite a curious appearance. The two most abundant species, *P. cornuta* and *P. orbiculare*, are known as the Mexican or horned frog, although there is nothing frog-like in their appearance. They feed upon insects, which they capture by stealing imperceptibly upon them; and they have the curious habit of feigning death, when handled, or even approached. *Pl.* 86, *fig.* 6, represents the latter of the species just mentioned.

The second sub-family, that of the *Acrodontes*, embraces species whose teeth are applied by their bases, and intimately united to the jaws. The anterior teeth differ in shape from the posterior. There are no palatine teeth. All the species belong to the Old World. *Lophyrus* (*pl.* 88, *fig.* 6) is a curious genus, inhabiting Asia and Africa. In *Draco* (*pl.* 74, *fig.* 76) the skin of the sides is extended out in the form of a wing supported by the prolonged ribs. By this means—which much resembles the flying apparatus of *Pteromys*, or the flying-squirrel, excepting that in the latter the

ribs do not support the membrane—the animal is enabled to glide in safety for a considerable distance through the air. The best known species is *D. daudini*, or flying dragon of Java (*pl.* 81, *fig.* 33, and *pl.* 89, *fig.* 3). The genus *Agama* (*pl.* 74, *fig.* 77) was formerly made to include the North American *Tropidolepis* and *Phrynosoma*. As restricted it now includes no American species. *Stellio* (*pl.* 74, *fig.* 78) contains the only European representatives of the *Iguanidæ*, *S. vulgaris*.

Fam. 5. *Chamæleontidæ* (the chamæleons). This family, containing but a single genus, *Chamæleo*, with 14 or 15 species, is separated by the most strikingly marked characters from all the other divisions of the *Saurian* order. The first peculiarity of the chamæleons consists in the absence of scales. The skin, however, unlike that of the *Batrachia*, is dry, and supplied with fine granulations of unequal size but of symmetrical distribution. The body is much compressed, so much so that the back and belly, in some cases, appear provided with crests. The feet, longer in proportion than those of any other saurian, are provided with five toes each, arranged in two sets, one including two and the other three. In the fore feet, the binary packet is exterior, the opposite being the case in the posterior extremities. In fact, the toes are all united together as far as the claws by the skin, and this then appears divided between the second and third, or between the third and fourth toes. The head is large, and, owing to the shortness of the neck, appears to rest on the shoulders. The orbits are very large, and the eyes are covered by a single annular pupil, with a dilatable central aperture. Either eye can be moved separately, and the two may be looking in entirely opposite directions at the same time. There is no external meatus auditorius. The mouth opens beyond the eyes, and is provided with trilobed cutting teeth, arranged in a single series along the sharp edges of the two jaws. A highly curious feature is to be found in the tongue, which, when at rest, appears like a fleshy tubercle, capable, however, of being suddenly protruded to a distance equal to the length of the body. The tip of the tongue is covered with a sticky secretion, by means of which small insects are secured. The tail is prehensile, and like that of the American monkeys can be used as an instrument of progression. The chamæleons are especially arboreal, a condition of life for which they are well fitted by reason of the opposable divisions of the feet and the prehensile tail. Their motions are exceedingly slow, and when stealing on their prey (minute insects) almost imperceptible. When arrived within a proper distance of the object of their pursuit, the tongue is protruded with inconceivable velocity, and retracted almost as quickly. The changes of color experienced by the skin of the chamæleon have made it an object of curiosity from the most remote time. Highly exaggerated notices of this phenomenon are to be found in the writings of many of the ancients; more recent investigations, however, have dispelled much of the fable attaching to this curious animal. A change of color, under different circumstances, is not peculiar to the chamæleon, but is exhibited by many of the tree-frogs, and in fact by most of the anourous batrachia. In all, it appears to depend, in some obscure way, upon the loose attachment of the

skin to the subjacent muscles,—a feature highly conspicuous in the chamæleon. The skin appears to be provided with various coloring matters, in different layers, which may be exhibited at or near the surface, under different circumstances and to different degrees, thus producing the various shades of color. These colors depend much upon external conditions, but are especially seen when the animal is irritated, or exposed to an elevated temperature. When remaining in a dark, cool place, the color of the skin is nearly white, which the stimulus of light and heat soon converts into a bottle-green, or venous red, this sometimes of such intensity as to appear almost black. These colors may be partial in their distribution, or may cover the whole body.

The family is represented by a single genus. *Chamæleo* (*pl.* 74, *fig.* 72), which is confined entirely to the Old World. Most of the species are African. One species, *C. vulgaris* (*pl.* 88, *fig.* 3), is found in the South of Europe.

Fam. 6. *Geckonidæ.* The *Gecko* family is eminently nocturnal, the entire organization fitting the species for this life. With some resemblance to the last, in some parts, the geckos are characterized in the first place by a clumsy, depressed body, so low on the legs as to permit the abdomen to drag along the ground; the greatest thickness is in the middle, and the back is without crest. The feet are short; the toes usually dilated, and provided beneath with transverse folds of skin, by means of which they are enabled to adhere firmly to the surface over which they may be moving. The claws are sharp, curved, and in some species retractile. The head is large and depressed, the mouth extensive, the eyes very large and protruding. In most species the pupil is a vertical slit, with or without denticulated margins. The tongue is short, fleshy, not protractile, and free at the extremity. The teeth are small, uniform, and implanted along the inner margin of the jaws. The tail is frequently provided with curious appendages, never, however, with a dorsal crest. The skin is granulated, somewhat as in the Chamæleons. In some species, it is extended along the sides and limbs into a kind of marginal fringe.

The *Geckonidæ*, unlike the last family, are pretty generally distributed. Asia, Africa, America, and Australia, divide the species pretty equally. Europe possesses two species. None are found in the United States, a species of *Platydactylus* having been assigned erroneously. The entire family may, with Cuvier, be conveniently divided into seven sections, according to the structure of the toes. In the first section, *Platydactyla*, the toes are more or less enlarged along their entire length, and provided beneath with transverse imbricated laminæ, which are either entire or divided by a longitudinal median furrow. A species of *Gecko*, *Platydactylus muralis*, is common in Southern Europe, where it excites attention by its power of ascending smooth perpendicular walls. It is this species which is called *Tarantola* or *Tarantula*, by the Italians. Another species, *P. guttatus* (*pl.* 88, *fig.* 4), is a native of Asia.

The second section, *Hemidactyla*, embraces species in which the toes

are dilated at the base only. A single species only, *H. verruculatus*, is found in Europe, the rest are principally Asiatic and Australasian.

The three next sections are known by the enlargement of the toes at the extremity only. In the first of these, *Ptyodactyla*, the disk is emarginate in front, and provided beneath with imbricated lamellæ arranged in a fan-shaped manner. One species, *Uroplatus fimbriatus* (*pl.* 88, *fig.* 5), inhabits Madagascar. The *Phyllodactyla* differ from the last in the absence of the inferior lamellæ. One species, *P. tuberculosus*, is found in California. The *Sphæriodactyla* have the toes dilated at the extremity into an entire disk, and are entirely without claws. The species inhabit the West Indies.

The two remaining sections are without the usual dilatation of the toes. One of them, *Gymnodactyla*, has the simple toes unmargined and with transverse striæ on the inferior face. The fifth toe of the hinder feet is versatile, answering the purpose of a thumb. Under this head is to be ranged the curious New Holland genus *Phyllurus*, with a tail flattened horizontally in the shape of a leaf. The concluding section, *Stenodactyla*, embraces but a single species, *Stenodactylus guttatus*, a native of Egypt. The simple cylindrical toes are indented along the edges, and are granular on the inferior face. The fifth toe of the hind foot is very slightly versatile.

Fam. 7. *Varanidæ.* This family, interesting on account of the size of some of its species, which comes next to that of the crocodiles, is also important for the light which it throws upon the organization of certain fossil saurians. The body is greatly elongated, rounded, or cylindrical, and without dorsal crests. The tail is slightly compressed, and several times as long as the body. The body is provided with non-imbricated tubercles, which are set in the skin, rounded, except on the belly, and arranged in circular bands or rings. The belly is frequently provided with angular plates. The tongue is more like that of serpents than of the other saurians: it is protractile, playing in a sheath, and deeply split into two forks, which are capable of separation. The teeth, which are usually pointed and recurved, sometimes tubercular, are confined to the jaws, where they are inserted by their roots in a common groove. Some of the *Varanidæ* attain to a size which, among living saurians, is only exceeded by the crocodiles. None, as far as known, are arboreal. They inhabit sandy deserts, rocky situations, or the banks of rivers, where they feed upon insects, or even the smaller vertebrate animals. The Monitor of the Nile, *Varanus niloticus*, is said to perform essential service in devouring the eggs of the crocodile.

Of the few species of this family, but one, *Heloderma horridum*, belongs to North America, where it is found in Mexico and California. None are European: Asia, Africa, and Oceania dividing the species pretty equally.

We shall now briefly indicate a few of the more conspicuous fossil saurians, whose alliance is, to a greater or less extent, with the preceding families, especially with the *Varanidæ*. The genera *Geosaurus* and *Mosasaurus* were gigantic forms, each represented in the cretacean

system of the United States; one, *Geosauris mitchelli*, from New Jersey, the other, *Mosasaurus maximiliani*, from the banks of the Yellowstone River. *Dicynodon* is a highly anomalous genus found recently in South Africa; and, in some peculiarities, exhibiting a resemblance to the *Chelonia* and to birds. There are no teeth at all along the margins of the jaws; but below each orbit there is a single cylindrical acute tooth, which appears to have grown at the base as it was worn away at the apex (as in the *Rodentia*), and presenting a character entirely unique among reptiles. Other genera are *Palæosaurus*, *Thecodontosaurus*, *Rhynchosaurus*, &c. There are obscure indications of species of *Varanus*, *Iguana*, *Lacerta*, *Scincus*, &c., or of very closely allied genera.

We come now to the consideration of *Saurians*, of a type of organization in many respects much superior to those hitherto considered. The most striking feature consists in the rhizodont character of the teeth, or the implantation of the teeth either in so many distinct sockets, or else in a deep furrow. Some authors make a distinct order of *Rhizodontes*. Comparatively few of the species known belong to the fauna of the present day; the remainder being entirely extinct, and exhibiting forms the most different from those which now abound on the surface of the earth. But one family has living representatives, and most of its species are now extinct.

This family, *Crocodilidæ*, the eighth of our classification, is readily distinguishable from other recent families by important characters, in addition to the implantation of the teeth in distinct sockets. The tongue is broad, fleshy, and entirely attached between the rami of the lower jaw. The latter are longer than the cranium. The skin of the head is closely adherent to the subjacent bone, and is without scales. The external nostrils are close together at the superior extremity of the snout, and are provided with movable valves. The posterior nostrils open in the pharynx, and not in the mouth, as in other saurians. The external ears also present an unique character, in being provided with two movable opercula, simulating the concha of the mammalian ear. The pupil consists of a vertical slit. The skin of the back is covered with solid bony shields, with longitudinal carinæ, and arranged in longitudinal bands. The belly is covered with transverse series of square plates. The greatly compressed tail is surmounted by longitudinal crests, and provided with whorled square plates. The anterior extremities have five distinct toes, the two exterior without claws; the posterior have but four toes, which are palmated, or semi-palmated; three only have claws. The penis of the male is simple, and the cloaca opens by a longitudinal slit, instead of the double penis and transverse slit of most other saurians.

The living *Crocodilidæ* are most abundant in the New World, where about one half of the entire number is found. Europe presents us with not a single species, Asia has three, and Africa perhaps four. Among the crocodiles of the present day, we distinguish three distinct genera, the alligators or caymans (*Alligator*), the true crocodiles (*Crocodilus*), and the gavials (*Gavialis*). The two first genera are distinguished from the last

by the comparatively short, broad skull. In *Alligator*, again, the fourth tooth of the lower jaw, or canine, is received into a cavity of the palatal surface of the upper jaw, where it is concealed when the mouth is shut: in old individuals the upper jaw is completely perforated by these large canines. The entire genus is confined to the New World. In *Crocodilus*, the first tooth in the lower jaw perforates the palatal process of the intermaxillary bone when the mouth is closed: the fourth tooth in the lower jaw is received into a notch cut in the edge of the upper jaw, and is visible externally when the mouth is closed. The genus is represented in the West India Islands, but probably not on the continent of America: it is also found in both Asia and Africa. The commissure of the jaws, in both species, presents a sinuous or waved margin, and the teeth are of unequal size. In *Gavialis* the jaws are very straight, and greatly elongated, so as to form a sub-cylindrical beak. The teeth are nearly equal in size, and similar in form, in both jaws; and the first, as well as the fourth tooth, on each side of the lower jaw, passes in a groove in the margin of the upper jaw when the mouth is closed. The best known species, *Gavialis gangeticus*, or the common gavial, is found in the Ganges, and probably in other rivers of Asia. The best known species of alligator proper is *A. mississippiensis*, a conspicuous inhabitant of North America. On the Atlantic coast, it occurs as far north as Cape Fear River in North Carolina. They were formerly very abundant in Florida, and of great size, individuals of 20 feet in length having been met with. They construct a curious nest, consisting of a cone of about four feet in diameter and height, composed of alternate layers of eggs and mud mixed with grass. The males in spring make a noise resembling the bellowing of a bull. *Pl.* 88, *fig.* 7, represents one of the South American alligators. The genus *Crocodilus* is illustrated by *C. vulgaris* (*pl.* 88, *fig.* 8), or the common crocodile of the Nile.

The *Crocodilidæ* of the present day all possess vertebræ with concavo-convex articulations, or the anterior face concave and the posterior convex. Instances of this same character occur in the fossil species. Others, however, as *Pleurosaurus*, *Teleosaurus*, *Macrospondylus*, &c., have concave articulations at both extremities. In a third series the reverse of the first takes place; the anterior articulations being convex, the posterior concave, as in *Streptospondylus*, *Cetiosaurus*, &c. About 70 fossil members of the family are known, comparatively few of these, however, belonging to the United States. Many species were of enormous size, exceeding those of the present day, although some of the latter have been known upwards of thirty feet in length.

Fam. 9. *Enaliosaurii.* The remaining families of Saurians are all composed of extinct species; many of them of enormous size, and of most remarkable organization, fitting them for the water, the air, the land. The enaliosaurians are the most highly aquatic of all known saurians, and perhaps of all reptiles. For this mode of life they were well calculated, by the highly unique structure of the extremities. While all other known reptiles never have more than five toes, nor more than five joints to each toe, the enaliosaurians have to each foot an indefinite number of toes, of an

indefinite number of joints, all united into a strong paddle or oar. In this respect they resemble fishes, an analogy which perhaps detracts from that eminence which the alveolar character of the teeth would imply. The entire framework is eminently calculated for progression in the water, the anterior extremities being more powerful than the posterior. The numerous vertebræ have biconcave articulating surfaces, and the bodies are rather broader than long. The immense eyes were provided with a bony sclerotic hoop, as in birds, composed of numerous pieces. This hoop, however, instead of being imbedded in the sclerotic of the eye, was probably attached to the margins of the orbit anterior to the eye. The teeth were large and conical, arranged in a longitudinal groove, bearing traces of a subdivision into alveoli. The skin was probably naked. The entire structure of the enaliosaurians indicates a highly rapacious character, well fitted to make them the terror of the deep. That their food consisted mainly of fishes is shown by the fact that their coprolites, or fossilized excrement, always contain scales or bones of these animals.

The enaliosaurians inhabited the seas of Europe during the deposit of the Trias and Jura formations. No species have as yet been detected in North America.

Of the numerous genera of this family, we have space to mention but two, which perhaps offer the extremes of structure. The first of these is *Ichthyosaurus* (*pl.* 74, *fig.* 83), a form which probably resembled that of some living cetaceans, as the dolphin. Like some of them, too, it was probably furnished with a vertical cartilaginous fin near the tail. The head was very large and pointed, the neck very short, and the tail very long: the entire animal having an acutely sub-fusiform shape. *Plesiosaurus* (*pl.* 74, *fig.* 82) presents conditions of external appearance precisely the reverse of the last genus. With a very small head, the neck was of such enormous length as greatly to exceed, in this respect, any other animal. Some species have as many as 40 cervical vertebræ, and the neck must have had a flexibility and freedom of motion far exceeding that of the swan, or any of the herons. In mammalia, this number never exceeds seven; birds have from nine to twenty-three; in living reptiles, from three to eight. The tail of Plesiosaurus was shorter, and the feet weaker and more slender than those of Ichthyosaurus. Some species of both genera exceeded 20 feet in length.

Fam. 10. *Pterosaurii.* Of all anomalous reptilian animals, *Pterodactylus*, the single genus composing the family, presents perhaps the most remarkable features. Even its position in the class *Reptilia* has been allowed, comparatively speaking, but recently, some writers assigning it to fishes, some to mammalia, others to birds; while a few saw in it a connecting link between the two last mentioned classes. Wagler went so far as to construct for it a new class of vertebrate animals, in which he likewise placed the enaliosaurians and the monotrematous mammalia. In appearance they must have somewhat resembled, when living, enormous bats; and would have well illustrated the fabulous dragon of olden times. The peculiarity which distinguishes the pterodactyle from all other reptiles is to

be found in the conversion of the anterior extremities into true wings. It is indeed true that one genus of living saurians, *Draco*, possesses the power of gliding through the air, but this is effected by means of the extended ribs alone, which, covered with skin, and margining the sides of the body, support the animal in its aerial movements, precisely as does the outstretched skin of the Pteromys, or flying squirrel. The entire structure of the pterodactyle fitted it for living in the atmosphere, where it probably possessed as much, if not more, freedom of motion than the bat of the present day. The lightness and hollowness of the bones, the bony connexion of the ribs with the sternum, the processes of the ribs, the numerous anchylosed sacral vertebræ, &c., all conclusively indicate this fact. The external or little finger of the anterior extremities, was of enormous development, and a membrane extended from this, probably to the tail, including the feet. The remaining four interior fingers were of moderate size, and all provided with strong claws. In the bats, it is the four external fingers which are greatly developed, and over which the wing membrane is stretched, leaving the thumb alone, of normal size, and provided with a claw. The elongated jaws were provided with teeth arranged at intervals, and each implanted in distinct sockets, to the number of from 10 to 34 in each jaw. The food of the smaller species consisted of insects, the larger preying upon fishes or the marsupial mammalia of their day. None of these highly curious animals have been detected in North America.

Fam. 11. *Dinosauria.* While the Pterosauria inhabited the air and the Enaliosauria exclusively the water, the Dinosauria seem to have had the dry land as the stage on which they played their part in the economy of an ancient world. The species of this family exhibit a striking mammalian feature in the anchylosis of five vertebræ to form the sacrum. In no other saurians, excepting the pterodactyles, is the number greater than two. The bones of the extremities were much developed, with crests for the attachment of muscles, and with a medullary cavity in the interior, as in mammalia and birds. The species were all of gigantic size, and divisible into two sections, the one carnivorous, the other herbivorous. The former, including the genera Megalosaurus and Hylæosaurus, exhibited peculiar serrated sabre-shaped teeth, arranged in distinct sockets; while the latter, embracing Iguanodon (and perhaps Plateosaurus) had teeth not unlike those of Iguana, which were pleurodont in their attachment to the jaws. For a long time the single species of Iguanodon was supposed to have attained a length of from 70 to 100 feet; and although this size is now denied, yet this gigantic saurian must be ranked among the largest of all terrestrial animals. Of the four known species of Dinosauria, none have been found out of Europe.

Fam. 12. *Labyrinthodonta.* This remarkable family should, perhaps, in a strictly natural arrangement, come next to or be included among the *Batrachia*, although several features would seem to require a position superior to that of the family just mentioned. The more essential differences consist in the implantation of the teeth in distinct sockets, and in the development of certain of the anterior teeth of both jaws into large and

formidable tusks. Other important points of distinction are to be found in the particular relations of several bones of the skull, some of which strikingly resemble those found in the crocodiles. The two occipital condyles impart a batrachian feature not to be found in any other saurian. Various genera are ranged in this family by the German palæontologists: the more conspicuous of these are *Mastodonsaurus* and *Labyrinthodon*, the latter of which, in addition to a close set series of nearly equal teeth along both jaws, has another along the anterior part of the outer margin of each vomerine bone. Two or three canine-shaped teeth, much larger than the rest, are placed in the intermaxillary bones, and in each vomer; other tusks being somewhat irregularly implanted in other situations. So few fragments of the rest of the skeleton have been found that we cannot have a clear idea of the animal, which may, however, have resembled a frog in external appearance. Some species are known to have possessed an armor of bony plates like that of the crocodiles. Not the least interesting feature of the *Labyrinthodonts* is presented by the peculiar structure of the teeth, a transverse section of which exhibits the most complicated cerebriform convolutions and sinuosities of the cement and dentine. The only parallel to this, among recent animals, is to be found in some species of the North American ganoid fish, *Lepidosteus* or the gar. It is highly probable that the curious hand-like fossil foot-marks found in Scotland and Germany, and provisionally assigned to a *Cheirotherium*, were impressed by some labyrinthodont. No species of the family have been found in North America.

Order 4. Chelonia.

The order *Chelonia*, or tortoises, is readily distinguished from other reptiles by the entire absence of teeth and the immovable union of the ribs and sternum into a kind of box, within which the soft parts are inclosed, and from which project the head, tail, and four extremities. This box is always broader than high, sometimes nearly as broad as long, and consists of two portions: one superior, or dorsal, called the carapace, or buckler; the other inferior, or ventral, known as the plastron or shield. The carapace is usually much arched, the degree of curvature varying with the family: the plastron is flat or sub-concave. The plastron usually consists of eight elements united in successive pairs, and a ninth occupying a notch between the first pair. In the carapace there are two sets of bony elements, one margining the other. This solid framework is covered by horny plates of various shapes and sizes, not necessarily similar in this respect to the osseous elements; more rarely by a simple coriaceous integument. The extremities are covered by a scaly skin. There are additional peculiarities in the osteology of the *Chelonia*, to which our limits forbid us to refer.

The head, neck, and tail are movable, and often retractile within the shell; the eyelids are always three in number; no external auditory

meatus; nostrils anterior; tongue fleshy, depressed, and thick. The cloaca is situated under the tail, with the orifice rounded and puckered. The male organ is simple.

Fam. 1. *Testudinidæ.* The family first to be considered embraces species which are exclusively terrestrial. They are known by their high-arched carapace, their full ossification, the complete investment of all the toes by a common skin, forming a true club-foot, on the exterior of which are to be found the blunt nails. The jaws are naked; the tympanum visible; the eyes lateral, with the lower eyelid higher than the upper. The tongue also is papillose. The four generic forms are, *Kinixys*, *Homopus*, *Pyxis*, and *Testudo*. But one of these genera, *Testudo*, is found in North America, where it is represented by a single species, *T. polyphemus*, or the gopher. This animal is found in Georgia and Florida, in sandy districts, where it excavates holes in the ground which much impede the movements of horsemen. Another species, *T. elephantopus*, is found in great numbers in the Gallapagos Islands, were they average 60lbs. in weight. They are eagerly sought for by the crews of vessels, and when captured serve for fresh meat, and may be kept in the hold of a ship for a year without food or drink. One species, *T. græca* (*pl.* 81, *fig.* 40), is found in the South of Europe; while *T. geometrica* (*pl.* 81, *fig.* 39, and *pl.* 90, *fig.* 13) lives in the East Indies.

Fam. 2. *Emydidæ.* In this family, the feet are more perfectly formed than in the last, the toes being five in number and movable, most generally united by a membrane or palmated. The mandibles are usually horny, trenchant, and naked. The tympanum is visible, and the eyelids are of equal height. The tongue, of nearly equal thickness throughout, is smooth at the surface, but presenting longitudinal folds. In most species the shell is considerably depressed.

This extensive family presents two sub-divisions or sub-families, whose distinguishing features are to be found in the shape of the head, in the position of the eyes, and in the manner in which the head and neck are retracted within the shell.

In the first sub-family, the *Cryptoderes*, the head is conical, sometimes as as high as broad; the eyes are lateral. The neck is short, thick, cylindrical, invested by a loose non-adherent skin. When the head is retracted the neck assumes an S shape, and both are nearly, if not entirely, concealed by the anterior margin of the shell, or by the loose skin of the neck. The most striking anatomical difference between the two sub-families is that in this the pelvis is attached to the carapace by a cartilaginous symphysis, and not at all to the plastron, this permitting a certain freedom of movement; while in the second sub-family, the pelvis is immovably attached to both carapace and plastron.

The first genus to be referred to among the Cryptoderes is *Cistudo*, which includes the common land tortoise (*C. clausa*) of the United States. Here the carapace is very high and arched, while the lower shell or plastron is divided into two pieces by a hinge, which enables them to shut close against the upper shell, and thus completely to inclose the entire

animal. The principal food of the land tortoise consists of vegetable matter, as fungi, of slugs, &c. Other species are found in the Old World, as *C. europæa* (*pl.* 81, *fig.* 41, and *pl.* 90, *fig.* 12). *Sternothærus*, with some resemblance to the last genus, has the anterior half only of the lower shell movable. The single North American species, *S. odoratus*, or the stinkpot of the Middle States, is a small species, exclusively aquatic, and often caught on a hook. It exhales a very disagreeable musky smell. Commonly confounded with this species is *Kinosternon pennsylvanicum*, a turtle of about the same size, but with the lower shell in three pieces, of which the middle is fixed, and the anterior and posterior move on this by cartilaginous hinges. The next noteworthy genus is *Chelonura*, or the snapping-turtle of the United States. Of this, there are two species, one confined to the South-West, and of immense size. The genus *Emys* includes species with depressed bodies and immovable plastron; five toes to the feet, the posterior with four claws only. Of this single genus there are 17 species known in the United States. The most remarkable is *E. terrapin*, the common diamond-back terrapin, so highly prized by epicures. It is caught in the brackish waters of the Chesapeake, and other bays and rivers, and commands a high price. Another species, *E. picta* (*pl.* 81, *fig.* 42), is exceedingly abundant.

In the second sub-family of the *Emydidæ*, or the *Pleurodeles*, the neck and head are not capable of complete retraction within the anterior part of the shell, but only partially to one side. The cranium is more or less depressed, and the eyes are more or less superior, and approximated. The skin which covers the neck is closely adherent to the subjacent muscles, and follows the neck in all its movements. None of the species belong to North America; many, however, to South America. The most remarkable is the *Chelys matamata*, or matamata tortoise of Cayenne, remarkable for the numerous fringes and other appendages which give it so grotesque an appearance.

Fam. 3. *Trionycidæ*. This family is known by the complete absence of scales upon the body, the shell being covered by a soft skin, and with free and flexible borders detached from the sternum. The feet and head are equally clothed with a naked skin, the latter without visible tympanum, and with nostrils prolonged into a kind of tube. The feet are provided with five toes each, with, however, but three claws. The species are all highly aquatic, with a much depressed shell, which, with their oar-shaped feet, well fits them for rapid progression in the water. But two genera are known, *Tryonix* and *Cryptopus;* species of which are found in North America, Asia, and Africa. Two species of *Trionyx* are found in the United States, where they are known as the soft-shelled turtle. One species is exceedingly abundant in the Mississippi and its tributaries. It bites readily at a night line, and is esteemed, in many places, a great delicacy.

Fam. 4, or the *Chelonidæ* proper, includes the marine species, which are all of immense size. Their carapace is much depressed, and the upper jaw usually presents a curved beak somewhat like that of a hawk. The feet

are true oars or paddles, with but a faint trace of one or two claws externally; the anterior are much larger than the posterior. There are two genera, one *Sphargis*, with a naked skin on the shell, and *Chelonia* with plates. *Sphargis coriacea* (*pl.* 81, *fig.* 43), or the leather turtle, is the largest of all living Chelonia, individuals having been known to weigh 1500lbs., with a shell six feet in length. *Chelonia imbricata*, or the hawks-bill turtle, found among the West India Islands, and in other localities, furnishes the valuable tortoise-shell of commerce. *C. mydas*, or the green-turtle (*pl.* 90, *fig.* 11), is highly prized by epicures. It is caught in great numbers among the West India Islands and on the coast of Florida, especially about Key West. Most sea turtles are vegetable eaters.

We shall now make a brief reference to the fossil *Chelonia*, having purposely deferred their consideration until the last. Numerous species of *Testudo* are found in the Tertiary of Europe, and one or two in that of Brazil. The Himalaya furnishes an enormous species of land tortoise closely allied to Testudo, in *Colossochelys atlas*, an animal which with a total length of 18 feet, had a carapace or back shell 12½ feet in length, 8 feet broad, and 6 feet high. The sternal shell or plastron was 9½ feet long, 8 broad, and over 6 inches in thickness. The feet must have equalled, or exceeded in size, those of the largest rhinoceros. Many species of *Emys* have been found in the Jurassic and tertiary strata of Europe. A species of *Chelonura*, or snapping-turtle, is described, from the Œningen marl. *Trionyx*, *Chelys*, and several other modern genera, have their fossil representatives. Fossil species of *Chelonidæ*, or sea turtles, are not uncommon in the Jurassic, cretaceous, and tertiary strata of Europe; and one species, *Chelonia cooperi*, is indicated from the State of Georgia. Many species of *Emydidæ* are found in the bone caves of Pennsylvania, most of them, however, identical with recent species.

VERTEBRATA.

Class III. Aves. Birds.

No class of the Animal Kingdom is more stongly marked or more competely isolated from other classes than that of Birds. Having the body covered with feathers, which are peculiar to this class, with the two anterior extremities analogous to the fore legs in quadrupeds transformed into wings, and an organization completely adapted to inhabiting the air, at various altitudes, during the greater portion of their lives, they are capable of swiftness of motion surpassing any other of the Vertebrata. and wander over the regions of space with great ease and celerity. We wish to be understood, however, as speaking of the general character of the class; for nature, ever disposed to vary her productions, has given to some species very limited powers of flight, and totally denied them to others.

For the purposes of flight, and especially for such long continued exertion upon the wing as may be observed in many birds, an admirable adaptation of anatomical organization subserves. It is obvious that a great degree of muscular power is indispensable, and we accordingly find it, and sustained too by a provision for producing the most energetic and protracted respiration. This is the curious arrangement by which the air which enters the body is not restricted to a pair of lungs, but is transmitted to various large air-cells in the abdomen and other parts of the body, and even into the interior of the bones. By this means the respiratory surface is incalculably extended, and the specific gravity of the body greatly diminished. There are also other anatomical characters, from which it is demonstrable that to be filled with air is the natural or healthy state of these cavities, and that they are always filled by active or unimpaired inspiration. This extraordinary arrangement is highly developed in rapacious and other birds which habitually fly to great heights in the atmosphere; but it is also found in great perfection in singing birds, and has evidently an additional use in enabling them by deep and less frequent inspirations to sustain protracted song.

For general elegance of form no class of vertebrated animals can be compared to birds, and they alone of the entire circle of animal life are gifted with voice which can be considered as musical or even agreeable to the ear. It is the latter character which immediately recommends them to all nations and classes of mankind, and establishes them as favorites. It has somewhat an aspect of misfortune, though, so far as relates to many of the pre-eminently superior songsters of Europe, the business of catching them and reducing them to subjection has been long pursued and carried on to an extent which would be scarcely credited in America.

Singing birds are almost exclusively restricted to the Insessorial or perching birds. The song was formerly supposed to be peculiarly the expression of love during the breeding season, but this is not strictly the case, for many species sing in the autumn long after the labors of incubation

have been accomplished, and it even appears to happen occasionally that a *bachelor* bird sings all summer apparently for his own exclusive amusement. Mr. Broderip, in Zoological Recreations, mentions a case of this kind as follows: "We have heard the wild thrush, one of the sweetest singers of his tribe, sing far into September, but we watched narrowly and never could find that he had a mate." He was either too much of a genius to be troubled with the cares of ornithological matrimony, or was culpably unambitious about perpetuating the ancient house of the Thrushes.

Many birds which have no song possess notes of remarkable beauty and purity of intonation.

It appears to be nearly or quite impossible to set to music any lengthened song of a bird. This is owing to its being, as termed by musicians, out of *time*. This remark does not imply, however, to some birds which have a few melodious notes; these can often be accurately recorded, though it must be borne in mind that it is nearly impossible to imitate them with any instrument.

Nearly all birds can be taught strains other than their natural notes, by the more or less long continued repetition of such in their hearing; and several families, especially of the Parrots, can be taught to imitate the human voice with considerable success. No animals except birds are capable of this kind of imitation. The strength and compass of a bird's voice depend on the size and proportionate force of the larynx. The male only possesses this organ in sufficient development; in the female it is weak and small. It is found by experiment that this organ may be greatly improved in all singing birds by exercise and habit, so as to greatly enlarge and improve the song. Nutritive food, fresh air, and exposure to sounds which excite attention and emulation, in the season of courtship especially, are productive of this effect.

The highest degree of merit as a songster, from time immemorial and by universal assent, has been awarded to the nightingale, of which we shall speak at length in its proper place, and also of the greatest of our American songsters, the mocking-bird.

In the economy of the bird the bill is, perhaps, the most important organ, as it not only performs the offices of the jaws in other animals, to some extent, but is also a substitute in a great measure for the hand or fore paw of other vertebrata. It has considerable analogy, however, to the lengthened snout of the crocodiles, or the long-nosed fishes or quadrupeds. By this organ the food is seized in all birds, and in rapacious birds it is constructed for tearing their prey in conjunction with the feet and claws, and such is the case also so far as relates to many of the small insect-eating birds. Some birds, the horn-bills (*Buceridæ*) for instance, have large and grotesque appendages to this organ, the uses of which have never been ascertained. (See *pl.* 103, *fig.* 2).

The possession of wings is the most peculiar character of birds amongst the vertebrated animals, but in several groups these members are so materially modified as to be almost useless. In very many of the Gallinaceous birds, which comprise the common fowls, the pheasants, quails, &c. (*pl.* 96), the wings are so short and weak as to be only capable of

restricted and noisy flight; while in the ostrich, emu (*pl.* 94, 95), and some swimming birds, they are only useful to assist in running or swimming. In all cases, however, there appears to be ample compensation in enlarged powers of the two latter methods of locomotion.

All birds are protected from external injury by a more or less densely arranged growth of feathers, which are their peculiar clothing. In the smaller birds these are frequently highly ornamental; while in the tribes inhabiting the water or found only within the limits of excessive cold, in which utility is more strictly an object, this clothing is remarkably compact, and adapted in the most wonderful manner to the retention of warmth. In the swimming birds it is absolutely impervious to water, and is constantly lubricated by an oily secretion from a gland near the rump, more or less developed in all birds.

The periodical renewal of this plumage is termed *moulting*, and usually takes place in all birds once in a year. It usually occurs several times before the mature plumage of the species is attained. The plumage alters also considerably in the course of a year, the brightest colors and otherwise most complete plumage being observable during the season of courtship and incubation; after which it fades and in some species a moult takes place, during which the male bird assumes a plumage resembling that of the female, only attaining his own again in the spring.

The digestive power of all birds is very powerful, and the demand for food is accordingly of frequent recurrence. All birds are great eaters, and seem necessarily to require a comparatively large quantity of food to sustain their active habits and peculiar organization. The food is at first temporarily deposited in a sac, which is merely an extension of the gullet, and termed the *craw*, from which it is generally transferred to the stomach proper. This is composed of two apartments, in one of which the food is moistened by a secretion from peculiar glands, and then transferred to the second part or *gizzard*, in which the digestion is completed. The *gizzard* is furnished with enormously strong muscles in birds which feed upon grains, as the common fowl, but in those which subsist upon animal food the muscles are of but ordinary development. Many birds swallow particles of sand or gravel, for the purpose, it is believed, of assisting the powers of digestion. The craw is wanting in some birds which feed upon soft fruits. In parrots and pigeons it has the function of secreting a milk-like substance with which the food of the parent is mixed, and afterwards disgorged for the purpose of feeding the young.

Of the senses possessed by birds that of sight is the most acute, and exceeds in power that of all other animals and even of man. The rapacious vultures and eagles have this sense in the highest degree, but all birds have it very acutely developed. The sense of smell does not seem to be at all remarkable in any birds, notwithstanding the opinion formerly entertained that by this sense vultures were attracted to their prey. This opinion has been completely disproved, and the fact fully established that they depend upon sight alone. Hearing is usually acute, and is very delicate in the owls, some of which are the only birds which have external

ears. The sense of taste is very imperfect in all birds, and touch little better, though the latter is amply developed in the ducks and other aquatic birds which seek for sustenance with the bill. In all other birds this sense is very dull, and almost exclusively confined to the feet.

Birds are eminently migratory. The majority of the species found in the temperate zones during the summer, rearing their young, pass the winter many degrees south of the place of their nativity, and even penetrate into the torrid zone. In the course of these migrations many of the small birds perform journeys which would appear almost incredible. Many of the American warblers, for instance, pass the winter on the shores of the Gulf of Mexico, and proceed in the spring as far north as Labrador.

The red winged starling and other birds of North America, known as blackbirds, also proceed during winter to the extreme southern limits of the United States; while a few species, such as the rose-breasted grosbeak and yellow-breasted chat, push into South America. The migrations of European birds are very remarkable, many of the common species passing the winter in Africa, some species crossing the Straits of Gibraltar, and others venturing boldly across the Mediterranean.

Pl. 105 *b* presents a view of the migrations of numerous species. These extensive flights are performed during both day and night; the latter time appears, however, to be that most universally adopted. Some small birds during their migrations fly at very considerable heights, much greater than is attempted by them at any other period.

Classification of Birds.

Birds occupy a station in the great circle of the Vertebrata between Quadrupeds and Reptiles. No class of animals has engaged the attention of naturalists to a greater extent, nor have their conclusions respecting subdivision or classifying been more various upon any other subject.

There are nearly as many systems as there are ornithologists.

We are disposed to look upon the circular or quinary system of Vigors and Swainson as the first approximation to the natural system, and in all respects the most philosophical. It will be impossible, however, to bring within our limits more than a mere outline of this remarkable system.

Birds are naturally divided into five orders, each of which, of course, is characterized by general characters. The following is according to the views of Mr. Swainson.

1. Insessores, or typical Birds, comprising all the well known Sparrows, Warblers, Thrushes, Woodpeckers, and other small birds. In this order is found the highest development of the general characters of Birds, the greatest variety and beauty of plumage, and an organization especially enabling them to live habitually amongst trees.
2. Raptores, or rapacious Birds, composed of the Vultures, Falcons, and Owls. These subsist entirely upon animal substances, and are the strongest and most powerful of all birds. They are strictly analogous to the tigers, dogs, hyenas, and other carnivorous quadrupeds.

3. Natatores, or swimming Birds, of which the Goose and Duck are familiar examples. They habitually live in the water, for which they are admirably constructed, like the whales, dolphins, and other aquatic mammalia to which they are analogous.
4. Grallatores, or wading Birds, well represented by the common Herons and Cranes. In these birds the long legs and neck are striking characters, and their entire organization has for its object the pursuit of such fishes or other animals as inhabit shallow waters or marshes.
5. Rasores, or walking Birds, represented by the domestic Fowl and the Turkey, by the Pheasants, Partridges, Quails, and other birds. They live almost entirely on the ground, and are almost the only birds which have been completely domesticated.

We cannot, however, possibly enter into any details of this system, and are sorry to say that it has not been elaborated by any author to such extent as to enable us to avail ourselves of his labors so far as to present a view of the various families of birds upon its basis. The reader can consult with great advantage, upon this subject, the volumes of Lardner's Cyclopædia by Swainson.

The publication of "The Genera of Birds" by George Robert Gray, an ornithologist of great acquirements attached to the British Museum, has placed in the hands of naturalists the most complete synopsis of the genera and species of birds ever produced. His method and views of classification we propose to adopt in the following pages.

Gray divides the class of birds into eight orders, as follows:

1. Accipitres, Rapacious birds. (*Pls.* 104, 105.)
2. Passeres, Sparrows, Thrushes, and generally all the small birds. (*Pls.* 99, 100, 101, 102.)
3. Scansores, Parrots, Woodpeckers, Cuckoos, &c. (Part of *pls.* 97, 98.)
4. Columbæ, Pigeons and Doves. (*Pl.* 96, *figs.* 12 to 15.)
5. Gallinæ, Cocks, Pheasants, Grouse, Turkeys, &c. (Part of *pls.* 95, 96.)
6. Struthiones, Ostriches, Bustards, and the Emu. (*Pl.* 94, *figs.* 1, 2.)
7. Grallæ, or Wading birds. (*Pl.* 93.)
8. Anseres, or Swimming birds. (*Pls.* 91, 92.)

These orders contain, according to the views of Gray, about fifty families, which are again divided into about one hundred and fifty sub-families, admitting about eight hundred genera.

The number of species of birds known is variously estimated. Gray enumerates in his great work about six thousand species, but Des Murs of Paris, in a beautiful and important work the Iconographia Ornithologica, now in the course of publication, and in which he intends to give plates of all known birds not previously figured, estimates them at ten thousand. The probability is that there are at this time about seven thousand well determined birds, many of which have been discovered since the commencement of Gray's work; and to this number constant and large accessions

must continue to be made. Linnæus in 1766, which is the date of the last edition of his Systema Naturæ, mentions only nine hundred and forty-seven species. The progress of discovery in ornithology may be inferred from the vast increase of known species since that period; and there is yet no symptom of cessation or respite, new discoveries being made almost daily.

The largest and most complete collections of birds in the world are those of the Academy of Natural Sciences of Philadelphia, of the British Museum, of the Royal Museum at Leyden, and of the *Jardin des Plantes* at Paris. The first is probably the most extensive, though the number of species contained in it has not been ascertained. There are upwards of twenty thousand specimens exhibited, which, with the other collections of the Academy, are with great liberality gratuitously thrown open to the public.

We shall now proceed to give in detail notices of all the families and subfamilies of birds nearly as proposed by Gray, and shall also give brief sketches of the principal genera and species, more particularly of those inhabiting North America and Europe, but shall not neglect others; hoping, upon the whole, to present to the reader a general view of ornithology sufficiently interesting to induce him to pursue further the study of this delightful branch of natural history.

Order 1. Accipitres, or Rapacious Birds.

Immediately recognised by their strong and hooked bills, their formidable claws, and an organization entirely adapted to the pursuit and destruction of other animals, or to subsisting only upon animal food. These birds are found in all countries, and, although not numerous, are universally known.

The rapacious birds comprise some of the largest of the whole class, and are by far the most muscular and powerful. They are usually solitary and very retired in their habits, and are more unproductive than any other birds. The female is the larger of the two sexes, and frequently has more handsome plumage.

This order contains three families, which are the Vultures, the Falcons, and the Owls.

Fam. 1. Vulturidæ, or Vultures. Head naked; bill more or less strong, sometimes rather long, hooked, and acute; wings long and pointed; tail moderate; tarsi short, strong, covered with scales; toes moderate; claws weak, but slightly curved. Size large; body thick and heavy; region of the crop or craw usually naked, or covered with woolly hair.

This family presents an assemblage of large birds of remarkably uniform general habits and history. The name vulture has not inaptly been borrowed to express features of character which are repulsive in our own race, but which are common to the whole family of useful but disagreeable birds now before us. Cowardly and excessively voracious, they delight in dead animal matter in all stages of decay and putridity, of their indulgence in which they usually give sufficient evidence in the offensive effluvia which emanate from their plumage. Nevertheless, the unenviable tastes of

the Vultures are directed to a wise end. They are the scavengers of the hot parts of the earth, performing valuable services in destroying dead animals immediately after life has ceased, in countries where large quadrupeds and all animals most abound.

It was long believed that Vultures were attracted to decaying matter by a very exquisite power of scent, which was supposed to enable them to distinguish it at a great distance. The testimony of modern naturalists, especially Le Vaillant and Audubon, has completely disproved this opinon. The former found it impossible to protect animals which he had killed, except by covering them, which he sometimes did, with branches and leaves of trees, and found that they were no more interfered with. Audubon made several careful and conclusive experiments to the same purpose. It would, however, perhaps be venturing too much to assert that birds of this family have not the sense of smell in rather an unusual degree, since a well developed olfactory apparatus has been satisfactorily demonstrated. We may safely conclude though, that in cases where Vultures are seen to converge from various directions in the atmosphere towards a recently dead animal, they are guided exclusively by their piercing vision.

Of all families of birds the Vultures sustain the most lofty flight. Thus the traveller in the highest ranges of the Andes often sees the Condor, the largest of Vultures, soaring yet far above him, a mere speck in the heavens. For this purpose they are well fitted by the lightness of their bones, which in some species are hollow throughout, even to the toes. The common Turkey buzzard (*Cathartes aura*) has a skeleton so light as to weigh little over four ounces.

Except in the capacity of scavengers the Vultures are of little economical importance. Nothing but the most direct and pressing necessity would cause their rank flesh to be eaten, and their feathers are not useful. They occur in all torrid and temperate regions, very abundant in the former and frequently met with in the latter, rarely passing beyond the limits of the temperate zone.

Sub-fam. 1. *Vulturinæ, or true Vultures.* Bill strong and somewhat elongated, more or less compressed, the basal half covered with a cere; upper mandible abruptly hooked; nostrils generally placed transversely in the cere and exposed; wings long; tarsi covered with small scales. Head naked, with the skin generally wrinkled and with scattering hairs; neck partially naked.

The true or typical Vultures are restricted to the old world, and are found in great numbers (though of few species) in the warmer parts of Asia and in Africa, while in Europe one species only occurs sparingly. Nearly all the species are large birds, and they perform the same offices of scavengers as their relatives, the Turkey buzzards and Carrion crows, do in America, in which capacity they are of great importance in the densely populated Asiatic cities, and, in fact, in all tropical countries. This subfamily presents in the highest degree the general characters of the Vulture family, the naked head, neck, and tarsi, by which they are better enabled to partake of their putrescent food than if those parts were clothed with

feathers. Truthful to the instinct of cleanliness, however, which appears to prevail amongst all animals, vultures are said frequently to wash themselves thoroughly.

Vultur monachus, Linn., is the European species; in addition to which there are of this sub-family two African and one Asiatic species (*Vultur ponticerianus*, Lath.), well known as one of the Indian vultures. Little or nothing is reported concerning them other than the general habits of the family.

Sub-fam. 2. *Gypinæ or griffin Vultures.* Bill lengthened, compressed, hooked, and very sharp. Wings long and powerful; tarsi moderate, very strong; tail rather long, rounded. Head more or less covered with hairs, more so than in the preceding. Size large; colors mostly fulvous.

This sub-family is composed of species which appear to be analogous to the more savage types of rapacious animals.

One species, *Gyps fulvus*, Linn. (*pl.* 104, *fig.* 9), inhabits Europe and is supposed to be common to Asia and Africa; it is popularly called the Tawny Vulture or Griffin, and by the latter name appears to have been known to the ancients. There are about four other species inhabiting Asia and Africa, the most remarkable of which are the Bengal Vulture and the Indian Vulture, which are in many places common features of Indian scenery and remarkable for their numbers and voracity.

Sub-fam. 3. *Gypaëtinæ or bearded Vultures.* Head and neck completely clothed. Bill strong, long, elevated towards the end, which is hooked. A well defined beard, or bunch of stiff hair-like bristles directed forwards from beneath the lower mandible, is the peculiar character of this sub-family amongst rapacious birds. Legs short, middle toe long. Wings and tail long, the former pointed and very powerful.

The bearded Vultures, with most of the characters of their family, have also the swiftness of flight of the Falcons, to which they have been attached by some ornithologists. This sub-family is composed of a single genus. *Gypaëtos*, of which the principal species is the *Gypaëtos barbatus* (Linn.), the Bearded Vulture or *Lämmergeyer* of the Alps. It derives its English name from the stiff beard-like tuft which characterizes the genus, and is much dreaded in some mountainous districts of Europe on account of its preying upon lambs and other young and feeble animals, added to which it has the traditionary reputation of being disposed to carry off young children when left unprotected within range of its keen sight. The latter, however, is not well established, and the form of its talons, which are weak as in all the Vultures, tends to throw further doubt on the subject; though, if very hungry, we would not trust him.

The same species is supposed to inhabit all the high mountain ranges of the old continent, but the birds inhabiting those of both Asia and Africa are represented by competent naturalists as different species, which is probably the case. If so, there are three species of the bearded vultures.

Sub-fam. 4. *Neophrinæ or slender-billed Vultures.* Bill much lengthened and slender. Nostrils longitudinal, nearly medial; cere extended; face and part of the neck only naked. Size smaller than the preceding.

This sub-family consists of two genera of small vultures inhabiting southern Asia and Africa, one of which, the *Neophron percnopterus*, Linn., occasionally visits Europe, and has been found in Great Britain. It has been represented as exceedingly disgusting in its habits, preying only upon decaying animal matter, and very familiar in the streets and neighborhood of cities. It is this species which is most frequently alluded to by travellers in countries (and especially the cities) of Southern Asia and Northern Africa, and is usually called the Egyptian Vulture. Another species has been discovered in Abyssinia: and a distinct genus, comprising only one species, is found in Western Africa. It is the *Gypohierax angolensis*, Gm., or the Angola Vulture.

These are all timid and weak birds, and devour all forms of animal filth with unexampled greediness.

Sub-fam. 5. *Sarcoramphinæ or American Vultures.* Head and neck more or less naked, and with the skin either carunculated or corrugated. Bill lengthened and rather slender, but strong at the tip, which is curved and acute; nostrils placed in the cere, with the opening large, exposed, and longitudinal. Wings long and pointed; tarsi long; middle toe long. Size various, comprehending the largest and the smallest of the vultures. Color black.

The species of this sub-family are peculiar to America and constitute two well defined genera, *Sarcoramphus*, or the Condors, and *Cathartes*, which includes the Turkey Buzzard and Carrion Crows. The Condor (*pl.* 104, *fig.* 11) is the largest of all rapacious birds. It inhabits Central and South America, generally frequenting the vicinity of the high mountain ranges, in which it rears its young at an elevation of ten to sixteen thousand feet above the level of the sea, above which it is represented by travellers as soaring to a vastly greater height. The eggs are laid upon the bare rock, two in number, white, and about four inches in length. The condor feeds principally upon young animals, but several in company are said to attack the llama and other large quadrupeds, and readily overpower them. Very extravagant stories were carried to Europe by the earlier voyagers respecting the size and prowess of the condor, some of which gained considerable currency, and in fact the bird and its habits were little known until observed in South America by the celebrated Humboldt. It appears, notwithstanding its large size and great strength, to partake in a considerable measure of the disposition to familiarity and susceptibility of semi-domestication which prevail amongst the carrion crows and other of the American vultures. Dr. Gambel, in an account of this bird published in the Journal of the Academy of Nat. Sci. of Phila., vol. i. p. 25 (quarto), has the following remarkable and interesting paragraph: "A condor which I saw at Valparaiso in 1845 lived at large in the city, and appeared to be an universal favorite. It would follow after or walk alongside of a person like a dog, and offered no resistance to being handled or having its feathers smoothed down: so good-natured was it that it would receive the caresses of children, and permit them to beat it with switches or even attempt to get upon its back. In fact, I have never met with any bird which exhibited more tame-

ness or greater confidence in man than this large and powerful condor." He adds, that this individual possessed its full powers of flight, and would occasionally soar to a great height, and, upon returning to the city, would alight upon a steeple or other elevated object. He continues: "It (the condor) appears to be frequently caught by the Peruvians and Chilians, and thus tamed. I have several times seen birds nearly full grown offered for sale on the mole or market-place at Callao, being confined only by strong strings passed through their open nostrils."

Bonaparte's specimen figured in his American Ornithology, vol. iv. pl. 22 (continuation of Wilson's Orn.), fully sustained the character given above, as the following extract (vol. iv. p. 21) will show: "The individual represented in our plate was remarkable for playfulness and a kind of stupid good-nature. During Mr. Lawson's almost daily visits, for the purpose of measuring and examining accurately every part for his engraving, it became so familiar and well acquainted that it would pull the paper out of his hands, or take the spectacles from his nose, so that Mr. Lawson" (the famous engraver of birds), "seduced by these blandishments, and forgetting its character in other respects, did not hesitate to declare the condor the gentlest bird he ever had to deal with." The best history of the condor extant is that in Bonaparte's volume above cited; it may be of interest to add that he introduces it as a bird of North America, from the fact that a bill and a quill feather were brought home by the celebrated travellers Lewis and Clark, and were supposed to have belonged to an individual killed in the Rocky Mountains. No later travellers have observed it, however, though it is quite probable it will be found to inhabit that lofty range. The male condor is said to be the larger, which, if a fact, is an isolated exception to the entire family of rapacious birds. (Proc. Acad. Philada., iv. p. 159.)

The King Vulture, *Sarcoramphus papa*, Linn. (*pl.* 104, *fig.* 10), is a species which has beauty of colors remarkable in a bird of this family. It is much inferior to the condor in size, and is very common in the lower countries and the neighborhood of some of the cities of South America. It is indolent and inactive in its habits. Bartram, the celebrated botanist, saw large numbers of a bird which he represents to be the king vulture, during his travels in Florida. Singularly enough, he has not been confirmed by any subsequent observer, and the fact of this bird ever having been seen in any of that part of North America on the Atlantic Ocean yet rests entirely upon his authority. It is, however, known to inhabit Yucatan and other countries of Central America.

The genus *Cathartes* is composed of several species, some of which inhabit North and others South America. The most remarkable is the Californian Vulture (*C. Californianus*, Shaw), which appears to be peculiar to the Pacific coast of North America. It is a large species, with the plumage entirely black, and is the bird alluded to as the "large black vulture" by travellers in those countries. It feeds upon carrion and dead fish, the latter of which it procures abundantly on the shores of the Columbia and other rivers. The nest is said to be built in the immense

pine trees of that region; and the eggs, two in number, are as large as those of the goose.

The well known Turkey Buzzard and the Carrion Crow belong to this genus. Both are abundant in the southern states of North America, where they are found to be so useful in the removal of dead animals as to be protected by law. The former species (*C. aura*, Linn.) inhabits the north, though sparingly, as far as about latitude 41°. It makes its nest in the hollow stump of a tree; its eggs are about the size of those of a turkey, of a yellowish white color, with dark brown and blackish spots. The young are covered with down of a white color, which gives them a very singular appearance, and contrasts strongly with the black plumage of their parents.

There is a small species (*C. burrovianus*, Cassin) which inhabits Mexico, somewhat similar to the common species (*C. atratus*, Bertram), but is much smaller. It is, in fact, the least of known vultures. America, therefore, produces the largest and smallest of the vultures of the world, which are the condor and the bird here alluded to. Those birds of this genus found in great numbers in South America were long supposed to be strictly identical with those of the northern continent, but have recently been represented to be different; they appear, however, to be strictly similar in their general characters and habits, which are the same as those of all other vultures.

Fam. 2. Falconidæ. Size greatly varied, but generally moderate and formed for rapid flight. Head and neck generally fully clothed; bill strongly curved and generally conspicuously toothed or festooned, very acute. Claws generally very strong and exceedingly sharp, especially those of the inner and hinder toes. Wings generally long; tail moderately broad.

The *Falconidæ*, which include the Hawks, Eagles, Kites, and other genera of similar general form and habits, exhibit the perfection of the rapacious characters. They differ essentially from the vultures; their forms are more graceful and their courage much greater. Endowed with great swiftness and generally much boldness and cunning, and with beaks and claws expressly adapted to such purpose, they prey almost exclusively upon animals killed by themselves. The larger species feed upon quadrupeds, birds, and reptiles; a few upon fishes, and many of the smaller live exclusively upon insects. The plumage varies greatly with sex and age, and maturity of plumage is usually only attained in several years. The female is usually fully one third larger than the male, and is frequently more vigorous and rapacious. The young have generally elongated spots on the breast and belly, where the adult has transverse bands or lines, or is unspotted.

The *Falconidæ* vary in size greatly, the largest species, the Great Sea Eagle of northern Asia and America (*Haliaëtus pelagicus*), being nearly the size of the condor, and one of the largest of birds; while the smallest, which is the little Java Hawk (*Hierax cœrulescens*), is scarcely superior in size to our common bluebird.

The geographic range of this family includes the whole world: it is in tropical countries, where life teems most profusely, that the species are

most numerous. They are everywhere, however, alike in habits, and the unrelenting destroyers of everything that has life.

Notwithstanding the nobility of character usually attributed to this family, there is little that is noble or magnanimous about them, except whatever of such may be attributed to their usually graceful forms, instinctive cunning, and soaring flight; on the contrary, they are in habits the veriest robbers and most pitiful thieves of the feathered tribes, and the writer begs leave to add, that there is more decent respectability and true nobility in one honest gander, plebeian though he may be, than in all the noble falcons and imperial eagles that ever lived. We are sorry to differ so materially from the generality of naturalists, but this is our opinion, in which we only acquiesce in the conclusion of the great Dr. Franklin, who thought the bald eagle had scarcely a sufficiently good character to entitle him to the distinction of representing the American republic, and hinted that the turkey would have done better. We will not, however, at present venture quite so far as to insist upon the latter.

Sub-fam. 1. *Falconinæ or true Falcons.* Bill short, very strong and sharp; upper mandible with a well defined tooth, sometimes two, and also more or less festooned; under mandible truncated or emarginated at the end. Feet strong, middle toe long, claws strong and acute. Wings usually lengthened and formed for rapid flight. Size moderate or small; never large.

In this sub-family we find the most complete development of characters indicating and in accordance with habits of rapine and violence. The boldest and most daring of birds of prey, their whole structure fits them for carrying on a life of warfare; their great muscular development, their long wings and powerful claws, enable them to pursue their prey with incredible swiftness and seize it with unerring and deadly grasp. The restricted genus *Falco* contains the species most noted in these respects, among which are some of the fastest flyers of all birds. Several of these were formerly highly valued when trained for falconry, especially the *Falco peregrinus*, Linn., or wandering falcon (*pl.* 104, *fig.* 5), which is an European species, but also found sparingly along the sea-coasts of the United States. It is known in New Jersey by the name of the duck hawk, and also as the bullet hawk, and preys almost exclusively upon ducks, which it overtakes and strikes upon the wing. The latter name (bullet hawk) appears to have been given from a supposition which is prevalent, that it actually strikes the duck with its breast and knocks it down by mere momentum. An inspection of its ferocious-looking beak and claws will, however, justify quite a different conclusion.

Another of the larger falcons is the Jer Falcon (*F. islandicus*), which is a native of the northern regions of both the Old and New Worlds, though most abundant in the north of Europe, braving the coldest climates, and, in fact, rarely making its appearance in temperate latitudes. It is of a beautiful white color striped with black, which with its courage seems to have made it a great favorite with falconers, and its use appears to have been almost monopolized by persons of noble blood.

There are several small species of this genus, all of which appear to have been trained for falconry, such as the merlin (*F. œsalon*), the hobby (*F. subbutes*, *pl.* 105, *fig.* 7), and others. Of North American species there are several, such as the pigeon hawk (*F. columbarius*), which is frequently met with throughout the United States, and the beautiful little sparrow hawk (*F. sparverius*), a familiar and remarkable bird inhabiting the whole continent. It may be seen in the Middle States throughout the year, especially, however, in summer, and excites attention by its capricious movements. Seated upon a fence or isolated tree, it suddenly darts to some point in the field, hovering in a peculiar manner over a single spot, and frequently returning unsuccessful to begin a fresh look-out. Spying a straggling grasshopper or beetle, it makes sure of him, and solaces its appetite leisurely. It rarely feeds upon anything else than insects, generally grasshoppers, an abundance of which is usually found in localities which it frequents. It builds its nest in the hole of a tree, sometimes in one deserted by a woodpecker, and lays four or five yellowish spotted eggs. The young are readily caught and easily tamed. It is a species very remarkable on account of its quiet and more bird-like habits than any other of our falcons, and has been ranked as generically distinct.

The Kestril, *F. alaudarius* (*pl.* 105, *fig.* 8), appears to resemble in many respects the sparrow-hawk, and is also clothed in gay plumage.

The foreign species of this sub-family are numerous. There is a South American genus (*Harpagus*, Vigors) and another of Africa (*Aviceda*, Swainson), which have two strong teeth in the upper mandible instead of one, which is usual. An Indian species (*Falco lophotes*) is probably the most beautiful of rapacious birds. In this sub-family we also find the very small hawks constituting the genus *Hierax*, Vigors, which are the smallest of the family. This distinction belongs to *H. cærulescens*, or the little Java hawk of the books.

Sub-fam. 2. *Buteoninæ, or Buzzards.* Bill short, broad at the base, much curved, festooned on the margins of the upper mandible Head usually broad and rather flattened. Wings long, though scarcely formed for rapid flight, tarsi rather lengthened, feet moderate, toes rather short. Size moderate, sometimes large, never very small.

The buzzards compose a sub-family of strong and massive formed birds with broad wings and soaring flight, but of inactive and rather sedentary habits. They feed on all descriptions of the smaller and weaker quadrupeds, birds or reptiles, nor do they reject the flesh of dead animals. Some species live almost exclusively upon frogs and snakes, others upon insects.

They are widely disseminated. Of the American species the red-tailed hawk (*Buteo borealis*, Linn.), and the winter falcon (*B. lineatus*), are the most common and universally known, and have received various names from the farmers and housewives amongst whose poultry, especially the junior part of it, in the sprіug, they make considerable havoc. They generally, however, go by the common denomination of hen hawks, or occasionally chicken hawks. These birds build their nests in

high trees, and it is when rearing their young that they are most destructive. They are destroyed without mercy by our agricultural population, and are becoming rare, as resident birds, in the more densely populated districts; but when the rigors of winter urge them to more excursive habits they are frequently met with. A smaller species is also occasionally seen in all the Northern States; it is the broad-winged hawk of Wilson (*B. pennsylvanicus*). It is a handsome plumaged and rather graceful bird, and comparatively harmless in its habits.

Of the European species the common buzzard, *B. vulgaris* (*pl.* 104, *fig.* 8), is the best known. In disposition and general history it is much like the common species of America. It is frequently met with in England and Scotland, and is disseminated over the whole continent; it has been observed to prey upon almost every description of small animals.

The genus *Archibuteo* comprises several fine species which have the legs completely feathered to the toes, and which are restricted to Europe and North America. Here is classed the black hawk of Wilson (*A. sancti-johannis*, Gm., *A. niger*, Wils.), a common species, though rarely seen in mature plumage, which is perfectly black; also another western species (*A. ferrugineus*, Licht.) which has recently become known.

Closely allied to the American black hawk, and resembling it in a remarkable degree when in young plumage, is the rough-legged buzzard of Europe (*A. lagopus*), a well known species disseminated over the entire continent, but appearing only occasionally in the south of England. Its history is little known.

Several of the South American species of this sub-family are remarkable for a beautiful white and black plumage, such as *Buteo melanops* and *B. pœcilonotus;* and one Mexican species is almost perfectly pure white, though the name is not so attractive, being *Buteo ghiesbreghtii.*

The African and Asiatic species are not numerous. Of the former may be mentioned several first made known by the celebrated Le Vaillant, such as *Circætus thoracicus* and *Buteo bacha;* and of the latter, *Buteo plumipes* and others.

Sub-fam. 3. *Aquilinæ, or the Eagles.* Bill moderate, rather lengthened and large, compressed, margins more or less festooned; nostrils large; wings long and generally pointed; tail long, ample, and usually rounded at the tip; tarsi and feet very strong, the former more or less feathered, the latter and generally part of the former covered with very distinct scales; claws very strong, much curved and acute, that of the inner toe strongest. Size large, flight generally very rapid and vigorous.

The eagles are distributed over the entire surface of the globe, and the typical species, the golden eagle, *Aquila chrysaëtos*, Linn. (*pl.* 105, *fig.* 1), is common to the northern parts of both continents; which is also the case with the typical fishing eagle, better known in the United States as the bald eagle, *Haliaëtus leucocephalus*, though it is rarely met with in the old world.

The eagles have been celebrated since the earliest times for their extraordinary vigor of flight, their large and graceful figure, and, we may

add, for some imaginary qualities which modern science has failed to demonstrate, but of which we will omit further notice, having, as the great Wilson observes of himself respecting the subject, "no ambition to excite surprise and astonishment at the expense of truth, or to attempt to elevate and embellish the subject beyond the plain realities of nature." Whoever wishes to find the subject treated in a very beautiful, but quite imaginative manner, can do so by referring to Buffon or Goldsmith's account of the golden eagle.

The habits of the golden eagle appear to be precisely those of the other large birds of prey; it generally captures living animals, but does not reject dead or even putrid bodies, though the reverse is distinctly asserted by the older writers. It builds in the recesses of mountains, laying two or three eggs. In America it is frequently met with, though most common on the western side of the continent. Its feathers are in much request among the Indian tribes as decorations, especially of the pipe of peace and other objects of their respect.

Of the typical eagles, which are characterized by densely feathered tarsi, there are several other species. The great black African eagle (*Aquila verreauxii*) deserves especial mention; he is larger than the golden eagle, and clothed in perfectly black plumage, except a space upon his back which is pure white. He would make a fine figure upon the coat of arms of an African republic. His habits have not been recorded.

The wedge-tailed eagle (*A. fucosa*, Cuv.) is another large species, inhabiting Australia, and remarkable for a peculiar shaped tail, the central feathers being longest. There are also other species found principally in Europe and the adjacent continents, such as the spotted eagle (*A. nævia*), the imperial eagle (*A. imperialis*), the little eagle (*A. pennata*), and several others.

The fishing eagles, genus *Haliaëtus*, consist of several species which are found in various parts of the world. In this genus is the great sea eagle of the north of Asia and America, *H. pelagicus*, which is the largest of its tribe. Little is known of its habits. Here too is classed the bald, or American eagle, which has had the good fortune to be immortalized as the emblem of our country. He lives principally in the neighborhood of rivers and upon the sea-coast, feeding mainly upon fish, which he does not hesitate to take by violence from more expert fishers, such as the osprey. This handsome bird does not attain his perfect plumage for several years, being in early stages entirely deep brown, without a vestige of the beautiful white head and tail which adorn the adult.

A large species has been described by Audubon as the Washington eagle (*H. washingtoni*), which, however, appears to be exceedingly rare, and much resembles the young of the common species.

The European sea eagle (*H. albicilla*) is a well known species, much resembling in general characters its American relative. It breeds in ledges of the elevated rocks upon the sea-coast, and is frequently a fine feature in the wild landscape of those localities.

There are several African species of the fishers, the most remarkable of

which is the vocifer of Le Vaillant (*H. vocifer*), the plumage of which, especially the white head, gives it somewhat the appearance of the American species. Several Indian species also occur, constituting the genera *Ichthyiaëtus*, Lafres., *Limnaëtus*, Vig., and *Spilornis*, Gray, all the species of which seem to partake of general characters and habits.

In this sub-family we find the ospreys, genus *Pandion*, one species of which is a common and familiar bird upon the North American sea-coast, known as the fish-hawk, and much respected as one of the harbingers of the fishing season. It builds a large and conspicuous nest composed of a great quantity of sticks and leaves, in which it is universally allowed by the people upon the coast to rear its young without molestation, though quite the reverse is practised towards all others of this family of birds. The European species, *P. ossifragus* (*pl.* 105, *fig.* 3), is distinct from that of the American coast, though very similar, as are others inhabiting various parts of the world.

The harpy eagles, genus *Harpyia*, Cuv., also belong here. The principal species is the great harpy (*Harpyia destructor*), which, in addition to a full share of other rapacious characters, possesses the most formidable claws of all known birds. It subsists on sloths, monkeys, and other quadrupeds. Other smaller species belong to this genus which are found in South America. Related to these are the very handsome crested eagles of the genus *Spizaëtus*, Vieill, which inhabit the same country; the *S. ornatus* is especially beautiful.

The African short-tailed eagle (*Helotarsus ecaudatus*) may be especially designated, if for no other purpose than merely to mention that although he is a bird nearly as large as the bald eagle, his tail is so short as to be scarcely discernible without examination.

The little Pondicherry eagle, or Brahman kite, as it is sometimes called (*Haliastur pondicerianus*), belongs here. It is a small species, with white and chestnut colored plumage, and is one of the most common of the Indian birds of prey. Many other species are found in various parts of the world. They are the largest of the birds of prey of this family, and are only equalled in size in the class of rapacious birds by the vultures.

Sub-fam. 4. *Polyborinæ, or Caracara Eagles.* Bill rather weak, and but slightly hooked at the tip, lateral margins of the upper mandible festooned or sinuated; wings long, tail long, rounded. Tarsi slender, naked, and covered with scales; feet moderate, rather weak; claws moderate, acute. Face and region about the eyes naked. Size small.

The *Polyborinæ* compose a small group of very peculiar birds confined exclusively to the warmer parts of America, one species only, *Polyborus braziliensis*, occurring as far north as Mexico, Texas, and occasionally Florida. It is rather remarkable for its beauty of plumage, and is said to combine the destructive qualities of the hawks with the indiscriminating voraciousness of the vultures. In fact these characters are attributed to all the species of this group, and are sanctioned by their appearance. Their naked faces and comparatively weak bills give them much the appearance of the vultures with which they have sometimes been classed;

while in general characters, structure, and in mode of flight, they are essentially members of the great family of the falcons.

The few species of this sub-family constitute the genera *Ibycter*, Vieill, of which *I. aquilinus* is the principal species; *Daptrius*, Vieill, of which *D. ater* is the only species: and *Milvago*, Spix, of which there are several, such as *M. ochrocephala*, and others; and the genus *Polyborus*, above alluded to. All the species are common in South America, but nothing is mentioned of their habits different from those of other birds of prey.

Sub-fam. 5. *Milvinæ, or Kites.* Bill rather short and weak, tip hooked and acute, lateral margins sinuated, nostrils oval, wings long and pointed. Tarsi short and slender. Tail long, ample, frequently forked or graduated. Size moderate.

The sub-family of kites is characterized by the remarkably graceful flight of all the species, many of which have also considerable beauty of plumage. The principal genus (*Milvus*) contains several fine species; one of them, the common kite of Europe, *M. regalis* (*pl.* 104, *fig.* 7), is one of the most familiarly known birds of its family inhabiting that continent. Other nearly allied species are found in Asia and Africa, none in America.

The honey buzzard (*Pernis apivorus*) of the South of Europe belongs here. It is a handsome species, and although as large as the winter falcon, feeds upon bees and other insects, the nests of which it is said to attack and destroy for the sake of the young. It preys also upon reptiles.

There are two North American genera, *Nauclerus* and *Ictinia*, which belong to this sub-family, each composed of a single species. The *Nauclerus furcatus*, or swallow-tailed hawk of the Southern States, is the most beautiful species. Its long and deeply-forked tail, white head, and glossy black body, added to its swift and graceful flight, make it conspicuous wherever it occurs. Abundant in the South, it occasionally strays as far north as Pennsylvania, and upon the Mississippi it has been seen as far north as the Falls of St. Anthony. It feeds almost exclusively upon reptiles and insects; and it is said that numerous individuals may often be seen upon the edge of the fires which sometimes occur upon the western prairies in the United States, darting like swallows amongst the smoke in pursuit of retreating grasshoppers and other insects. The swallow-tailed hawk is abundant in Florida during the winter season, but appears to breed further northwards. It has the remarkable habit of feeding upon the wing, holding its recently acquired plunder in its claws somewhat like a parrot.

The *Ictinia plumbea*, or Mississippi kite, is another common Southern species. It feeds chiefly upon insects, with an occasional relish of reptiles or small birds.

Species of two other genera, *Elanus* and *Rostramus*, have been found in the extreme south of the United States. The *Elanus leucurus*, or white-tailed hawk, and the *Rostramus hamatus*, or little hookbilled kite, have been observed in Florida. Of either of these species little is known, though both appear to be common in South America. The latter is remarkable for its very slender and hooked bill.

This sub-family is represented by several African and Asiatic species, of which may be mentioned those composing the genera *Avicida* and *Baza*. while in South America we find the genus *Cymindis*, of which there are several common species. The *C. cayanensis* is one of the most numerous; another remarkable for its disproportionately large bill (*Cymindis wilsonii*) inhabits the Island of Cuba.

Sub-fam. 6. *Accipitrinæ, or Sparrow Hawks.* Bill short, much curved from the base to the tip, which is very sharp, margins conspicuously festooned; head small; wings moderate; tail ample. Tarsi lengthened, middle toe much the longest, anterior claws very unequal, the inmost being much the strongest. Size generally small, never decidedly large.

The numerous birds of this large sub-family are distributed throughout the world, though each continent has peculiar species. They are generally characterized by their slender elongated bodies, rounded wings, and long tail, and are amongst the fiercest and most destructive of all the hawks. While the true falcons, eagles, and buzzards, are in great measure restricted to such prey as may be accidentally exposed, the sparrow-hawks push boldly into the densest thickets and deepest recesses of the forest in pursuit of birds and small quadrupeds which habitually resort to such localities.

The most remarkable species of this sub-family are the goshawks, the European species of which is the *Astur palumbarius* (*pl.* 105, *fig.* 5). It is a beautiful bird, with lead-colored and white plumage, and was formerly held in high estimation for the purposes of falconry. This species is more frequently represented in pictures having falconry for their subject than any other. The American species, *A. atricapillus*, is very similar to its European brother; it is frequently met with along the northern frontier of the United States, and occasionally ventures as far south as Philadelphia. Little is known of its history.

A second American species, Cooper's hawk (*A. cooperi*), is much more frequent. It is about one third less than the goshawk, and of the same active and destructive habits; it is very extensively diffused over the continent, having been observed from the sea-coast of New Jersey to the Rocky Mountains and Mexico.

The genus *Accipiter*, which belongs to this sub-family, contains the smallest hawks of Europe and America. Of the former continent the common sparrow-hawk, *A. nisus* (*pl.* 105, *fig.* 6), is the smallest. It is widely distributed, and is a very bold and successful little hunter after small mammalia, birds, and insects. The smallest American species is the sharp-shinned hawk of Wilson, *A. fuscus*, which is remarkable for possessing almost exactly the plumage of the much larger Cooper's hawk, and resembles to a considerable degree also the sparrow-hawk of Europe. Incapable, of course, on account of its diminutive size, of seizing any other than the smallest animals, it is yet conspicuous for the ferocity of its attacks upon small birds or young chickens. It is the "chicken hawk" of the farmer, and has well earned its appellation. Rather less than the sparrow-hawk, it may at once be distinguished by its more slender form,

longer tail, and more active and shy habits; its breeding place is not well ascertained, notwithstanding that it is a common species.

One genus only, *Micrastur*, Gray, is exclusively confined to tropical America, two species of which, *M. brachypterus* and *guerilla*, are found as far north as Mexico. They differ from the other *Accipitrinæ* in having stouter and much stronger bills, and are otherwise more robust. The latter species, *M. guerilla*, was discovered in Mexico by a young naturalist, who was attached to the American army, under General Scott, during the late war.

There is also one African genus, *Micronisus*, Gray, of which the *M. gabar* is the best known species, resembling, however, in most respects its European and American relatives.

Sub-fam. 7. *Circinæ, or Harriers.* Bill weak, high at base, compressed, greatly curved to the tip, margins slightly festooned in the middle, cere large, gape wide, ears large, and surrounded by a ruff of thickly curved feathers, similar to those of the owls. Wings long and pointed; tail long, broad, and generally rounded. Tarsi long, slender, smooth; toes short; claws moderate, very acute. Size greatly varied.

In this, the last of the seven sub-families which constitute the great family of the *Falconidæ*, we find characters begin to show themselves indicating a relationship to another family, the *Strigidæ*, or owls, which we are approaching, but still retaining the essential and unmistakable characters of their own family.

The typical genus *Circus*, well represented by the hen harrier of Europe (*C. cyaeus*), has a decidedly owl-like ruff of small recurved feathers around the face, and the eyes of all the species have a less lateral aspect than those of any other falcons. The species just mentioned is common throughout Europe; its plumage varies very greatly during its progress to maturity, a circumstance which has caused it to be mistaken by the earlier naturalists, and the same bird to be described as several different species. The fully adult bird is light sky blue with the under parts white, and is a handsome and showy bird. It is very shy and harmless in its habits, living almost entirely upon reptiles. There are several other European species, of which the moor buzzard (*C. æruginosus*), is, perhaps, the most remarkable. Its geographical range extends into Africa; it is said to frequent the vicinity of swamps and rivers, and to feed upon small aquatic birds and the eggs of larger species, and upon snakes, frogs, and other small animals.

One species only of this sub-family inhabits North America, which is the marsh hawk (*C. uliginosus*), one of the most common species. It is an exceedingly graceful bird when flying, and may often be seen about marshes and meadows, constantly on the wing near the surface of the earth, in search of small quadrupeds and reptiles. The young bird has its plumage of dark reddish colors, with a very conspicuous snow-white rump; while the adult, which is more rarely seen, is of nearly the same light blue color as its European representative. It appears to be particularly fond of frogs, upon finding one of which it generally secures him with its exceedingly short claws without difficulty, and if undisturbed devours him on the

spot. It builds its nest usually on the ground, and breeds throughout the United States.

Several South American species are known, though their history has never been investigated; they are *C. palustris*, *C. histrionicus*, which is a bird remarkable for its gaily striped plumage, and others.

The only hawk which possesses a musical voice, the singing hawk of the old authors (*Melierax musicus*), belongs to this sub-family. It is a common bird in Southern Africa, and is described by Le Vaillant as capable of performing quite respectably a considerable variety of notes. It appears to be a timid species, living upon reptiles, and partaking of the general habits of its family.

Here also has been classed a curious African genus, *Polyboroides*, the species of which have entirely bare faces, and necks also bare to some extent. They appear, however, to be more nearly related to the *Polyborinæ*, or to the vultures. Little is known about them beyond the mere fact of their existence in Western and Southern Africa, and future investigations must decide their claims to classification.

The extraordinary and apparently anomalous genus *Serpentarius* has also been assigned by late ornithologists to this sub-family. The only species is the secretary, or great serpent-eater, of the plains of Southern Africa, which, with a decidedly aquiline head and beak, has the long legs of a crane, and lengthened crest and tail. It lives almost exclusively upon the larger snakes, the most poisonous species of which it is said to seize with much dexterity and despatch with great quickness, regardless of their bites upon its long and well shielded tarsi. Spending its time in search of serpents, this powerful bird constantly walks upon the ground, presenting more the appearance of a crane, or large heron, than a bird of prey. It is a shy and very cautious bird, and is regarded by the colonists as very useful in destroying serpents, which it pursues on foot. The stomach of a specimen examined by the celebrated Le Vaillant contained no less than three snakes, eleven lizards, and portions of others.

With this sub-family we conclude the Falconidæ, and now proceed to the last family of rapacious birds.

Fam. III. Strigidæ, or Owls. Head usually very large; eyes large, directed forwards, and surrounded by a circle more or less complete of slender hair-like feathers, forming a facial disk. Bill short, generally strong, and partially concealed by projecting bristles, curved and much hooked. Wings usually strong. Tarsi short, and usually thickly clothed with short feathers, but sometimes naked or partially covered; claws long and acute. Plumage soft, habits almost exclusively nocturnal.

This family embraces the nocturnal birds of prey, all of which are familiarly known under the general cognomen of owls. They differ in many respects from the birds of the two preceding families, but yield to them in nothing of the ferocity or destructiveness characteristic of this class. The most striking and peculiar external character of the owls is the position of their large and staring eyes, which enables them to look directly forwards, and is not the case in any other birds. Their soft and

loose plumage is also quite characteristic, but is not peculiar, being occasionally met with in the *Caprimulgidæ* (night-hawks).

The brain is more voluminous than in other rapacious birds, and is protected by a remarkably thick, cellular cranium, which contributes to the great size of the head, as apparent in the living bird. The organ of hearing is very large and possesses much quickness and delicacy, and a peculiar formation of the eye gives the owls a power of sight of the most exquisite character. It is so constructed that the small amount of light at twilight, or even in the night, is sufficient to produce perfect vision, though the full daylight is too strong and dazzling for most of the species.

The flight of the owls is less graceful and less capable of being long continued than that of the preceding families. It is produced by repeated flappings and has the advantage of being entirely without noise, owing to the peculiar general structure of the wings, and a fine hair-like web on the outer edge of the first quill. They are thus enabled to steal upon their prey unawares and under cover of the darkness of night.

Their plumage is almost invariably of dull and uniform colors, and is in a great measure free from the diversity characteristic of age and sex in the *Falconidæ*. Being nocturnal strictly, or active only in the twilight of the evening or the morning, is generally characteristic of this class; a few species, however, are diurnal, and pursue their prey or attend to the wants of their young in the full glare of daylight. Of these the great snowy owl (*Nyctea nivea*) and the hawk owl (*Surnia ulula*), both found in the northern parts of America, are examples. These are exceptions only, much the greater number of species being of the former character.

The owls rarely devour any animals which have not recently suffered death, though they are not always contented with being themselves the instruments of destruction; some species instinctively follow the hunter in the northern countries, and pick up with eagerness grouse and other birds recently killed by his gun. Their period of activity being in the night, their repose is necessarily during the day, and if then disturbed most of the species make gestures of a very ludicrous character, which seem chiefly intended, however, to enable them to get a fair view of the intruder. Some species fly off immediately upon perceiving that they are discovered.

Some owls tear their food like the falcons, but the greater number swallow small quadrupeds, birds, and insects entire, subsequently ejecting from the mouth the hair, bones, and other indigestible matter rolled into pellets by a peculiar action of the stomach. Their food is entirely animal, and embraces every living thing which can be conquered by force or stealth.

The nesting-places of the owls are usually in hollow trees, fissures, or caverns in rocks, dilapidated buildings, or similar places. They also frequent such localities habitually during the day, or sometimes the protection of a pine tree serves them when *belated* in the *morning*. This peculiar family has been regarded with feelings nearly akin to superstition from the earliest ages. The grotesque and oddly-shaped forms of most of the species, their preference for the darkness of night or the gloomiest

recesses of the caverns or the forest, their shrill hooting voices, and above all their staring goggle-like eyes, have combined to form for them attributes of mystery, and occasionally of veneration or of terror. Elevated by the refined Greeks to be the symbol of wisdom, by several modern European nations the owl is known by no other name than "night hag," and its character regarded equally contemptuously. No other bird has flourished so largely amongst the poets. Virgil introduces it in various passages; Shakspeare gives great effect at its expense to the exclamation of Lady Macbeth in the murder scene:

> "Hark! Peace!
> It was the owl that shrieked, the fatal bellman
> Which gives the stern'st good night—he is about it."

More pleasantly, and without such a repulsive part to play, Coleridge makes him sing in a chorus in "Christabel:"

> "'Tis the middle of the night by the castle clock
> And the owls have awakened the crowing cock,
> Tu-whit!—tu-whoo!
> And hark again!—the crowing cock
> How drowsily he crew."

Sub-fam. 1. *Striginæ, or Barn Owls.* Head large with the facial disk complete or nearly so. Ears very large and with an operculum. Wings usually long; tarsi moderate; legs long and rather slender. Size much varied.

To this sub-family belong several of the most common American and European owls. The American barn owl (*Strix pratincola*) is a species which, though not abundant, is generally known. It is, notwithstanding its curious and rather comical physiognomy, a graceful and handsome bird. The common *Strix flammea* of Europe (*pl.* 104, *fig.* 1) very nearly resembles the American species, and was long considered the same bird; this remark applies, in fact, to several other species found in various parts of the world. The European species is the bird usually alluded to by authors, in English literature, as "The Owl." It is he who "mopes in the ivy mantled tower" and "chaunts high mass at midnight" in many an abbey where no one else does nowadays.

Two other common American species are the long-eared and the short-eared owls (*Otus wilsonianus*, and *brachyotus*), both of which inhabit the whole of North America. The latter, represented in *pl.* 104, *fig.* 2, is common also in Europe. It is partial to meadows and marshes, and is not afraid to venture from its hiding-place by daylight as are the majority of owls. The former is found exclusively in the deep pine or other forests, and is a very shy and retired species. The long-eared owl of Europe (*pl.* 104, *fig.* 3) much resembles that of North America.

The barred owl (*Syrnium nebulosum*) is the most familiar and abundant of all the large North American species. It may frequently be met with

in the pine or cedar lands, and may immediately be recognised by its entirely black eyes and head without horns or ear tufts. It usually preys upon small mammalia and birds, but it is said to resort occasionally to fishes and reptiles. It breeds in the forests of all the Northern States, making a nest in the forks of a large tree, and like some other owls lays eggs which are perfectly spherical.

Another species, the great grey owl (*S. cinereum*), is a rare visitor in the United States, though common in the north. It is one of the largest of owls, with plumage of an almost uniform deep grey. The screech owl of Europe (*S. aluco*) belongs here. It is a common species, and appears to be similar in its habits and history to our barred owl. Many other species are found in all parts of the world.

Sub-fam. 2. *Buboninæ, or Horned Owls.* Head large, broad, and furnished with two conspicuous tufts of feathers capable of being erected (usually called ears). Facial disk not perfect; ears moderate; bill short, strong, and curved; legs and feet robust, with the claws very strong and sharp. Size various, frequently large. Tarsi densely feathered.

The Great Horned Owl (*Bubo virginianus*), which is the largest species common in the United States, is a good illustration of this sub-family. Though still quite common in Western America, it has become almost extinct in the more densely populated districts of the States upon the Atlantic seaboard. It is, however, sufficiently well known for its depredations upon the poultry of the housewife, and for its peculiar and sonorous notes in almost all parts of North America. Wilson most admirably describes this bird in the first volume of his incomparable Ornithology. "This noted and formidable owl," he says, "is found in almost every quarter of the United States. His favorite residence, however, is in the dark solitudes of deep swamps, covered with a growth of gigantic timber, and here, as soon as evening draws on and mankind retire to rest, he sends forth such sounds as seem scarcely to belong to this world, startling the solitary pilgrim as he slumbers by his forest fire,

'Making night hideous.'

Along the mountainous shores of the Ohio, and amidst the deep forests of Indiana, alone, and reposing in the woods, this ghostly watchman has frequently warned me of the approach of morning, and amused me with his singular exclamations, sometimes sweeping down and around my fire, uttering a loud and sudden 'Waugh, O! Waugh, O!' sufficient to have alarmed a whole garrison. He has other nocturnal solos no less melodious, one of which very strikingly resembles the half-suppressed screams of a person suffocating or throttled, and cannot fail of being exceedingly entertaining to a lonely benighted traveller, in the midst of an Indian wilderness.

"The great horned owl is not migratory, but remains with us the whole year. During the day he slumbers in the thick evergreens of deep swamps, or seeks shelter in large hollow trees. He is rarely seen abroad by day,

and never but when disturbed. In the month of May they usually begin to build. The nest is generally placed in the fork of a tall tree, and is constructed of sticks piled in considerable quantities, lined with dry leaves and a few feathers. Sometimes they choose a hollow tree, and in that case carry in but few materials. The female lays four eggs, nearly as large as those of a hen, almost globular, and of a pure white. It is conjectured that they hatch but once in the season."

Several large species are found in Europe, one of which, *Bubo maximus* (*pl.* 104, *fig.* 4), the Grand Duke, as it is called upon the continent, is the largest of all the owls. It is common in the forests of the North of Europe, and is more or less met with throughout the continent, though rare in the British Islands.

Other species of the great horned owls inhabit various countries of the world, all of which are of large size, and many of them possess considerable beauty of plumage. In South America are found the *B. magellanicus*, and *crassirostus*, both much resembling the northern species. India has several fine species, *B. bengalensis*, *orientalis*, and *coromandus*. In Africa, also, several species are found, one of which, *B. lacteus*, is very large, with the under parts of the body of a pure white color.

In India is found a remarkable genus (*Ketupa*), which differs only from the great horned owls in having long and entirely bare legs.

The common small or screech owls, as they are usually called in the United States (*Ephialtes navia*, and *asio*), belong to this sub-family. The two here mentioned are usually considered to be the adult and young of the same bird, and are the most familiar and best known of the North American species. Both are common in the Northern and Middle States, and come in the dusk of the evening boldly about the houses and out-buildings of the farmers, and even may occasionally be seen in the cities. The notes of the screech owls are peculiarly melancholy, and are no favorites with the juvenile population; and, in fact, not at all pleasant to us of a larger growth. The nests of the screech owls are made in hollow trees, of a little grass or leaves, in which three to five eggs are laid, perfectly white and nearly globular.

Some twelve other species of these small horned owls inhabit all parts of the world except Australia.

Sub-fam. 3. *Atheninæ, or Bird Owls.* Facial disk imperfect; bill moderate and usually exposed; wings and tail moderate, rounded. Tarsi and feet moderate, sometimes long, but partially feathered. Size usually small. Head smooth, without egrets.

The principal genus of this sub-family is *Athene*, which comprises numerous species of small owls distributed throughout the globe. A species inhabiting the island of Cuba, the *A. siju*, is the smallest of all the owls, and several others found in South America and Mexico are but little larger.

Three species have been observed in North America, no one of which has yet been found upon the Atlantic seaboard. In California the *Athene passerinoides*, one of the smallest species, has been observed. It is about

the size of the common bluebird, and preys almost entirely upon insects. The most remarkable species of North America, and one of the most curious birds of this family, is the Burrowing Owl (*A. hypugea*), inhabiting western America, which lives in a hole in the ground, instead of taking up its abode in a hollow tree like the others of these birds. It is said to make an excavation occasionally for itself, but more commonly takes possession of one already finished by the prairie dog (*Arctomys ludoviciana*), in which it makes its nest and rears its young. One of the most singular features in the history of this bird is that it inhabits a hole frequently in the midst of a large village or settlement of these animals, with which it appears to live in perfect harmony. This remark applies, however, also to various kinds of rattlesnakes, which have a partiality for the villages and comfortable quarters of the prairie dog, and both have been suspected of a liking for the young of their entertainers. Travellers disagree, however, upon this point, so that it remains unsettled whether the owls and rattlesnakes most relish the good fare or the pleasant society of their hosts. The burrowing owl is strictly diurnal, and devours grasshoppers and other insects, and small quadrupeds; according to the Indians, it retires to the depths of its burrow in autumn, and spends the winter in a state bordering on torpidity.

Australia produces several species of this genus which are remarkable for their large size, though in all other respects they are very similar to the minute owls above alluded to.

Two large species, constituting the genus *Ciccaba*, are classed in this sub-family, one of which, *C. personata*, in young plumage has a black space around each eye, presenting the appearance of a pair of spectacles, on account of which it has acquired the name of the spectacled owl.

Sub-fam. 4. *Surninæ, or Hawk Owls.* Head comparatively small, with the facial disk imperfect; eyes small, deeply sunk in the head. Wings long; tarsi short and densely feathered; claws strong. Diurnal.

Two species only are included in this sub-family, both of which are almost restricted to the Arctic regions, visiting only the northern parts of the temperate zone, in both continents, during the winter. They are the great snow owl (*Nyctea nivea*) and the hawk owl (*Surnia ulula*).

The former is a large species, distinguished for its plumage of beautiful snowy whiteness. Its tarsi and feet are so thickly clothed with plumes that they often entirely conceal the toes, and when the bird is sitting at rest frequently nothing but the black tips of its claws is visible. The eyes, which are very large, are of a beautiful gamboge yellow, which contrasts advantageously with its white plumage. This magnificent bird is abundant in the extreme northern regions yet attained to by voyagers, and frequently visits in winter the northern countries of both continents, but appears to be the more plentiful in North America. It is often shot in the neighborhood of Philadelphia during some winters, and those, too, are frequently such winters as are remarkable for their mildness; however, more or less numerous specimens find their way to city markets every winter, and it probably wanders occasionally to the southern limits of the United States.

The Snow Owl is often seen in Norway and Sweden, but is of rare occurrence in France or the British Islands. In Ireland it appears to be of more frequent occurrence than in Great Britain.

Audubon mentions that a specimen in captivity fed upon small fishes or pieces of fish placed in water, and Wilson also mentions having seen this bird engaged in fishing. Its usual food is said, however, to be the northern hares, grouse, ducks, mice, and even carrion, which it feeds upon by daylight as well as in the twilight of the evening. It breeds in the far north, and is said to make its nest upon the ground, and to lay three or four white eggs.

The Hawk Owl is another northern species, though not inhabiting regions so far north as the preceding, nor does it proceed so far south in its winter migrations, being very rarely found in the latitude of Philadelphia. Wilson's description of this curious bird is, as usual, much to the purpose: "This is an inhabitant of both continents, a kind of equivocal species, or rather a connecting link between the hawk and owl tribes, resembling the latter in the feet and in the radiating feathers around the eye and bill, but approaching nearer to the former in the smallness of its head, narrowness of its face, and in its length of tail. In short, it seems just such a figure as one would expect to see generated between a hawk and an owl of the same size, were it possible for them to produce, and yet is as distinct, independent, and original a species as any other. It has also another strong trait of the hawk tribe, in flying and preying by day, contrary to the general habit of owls. It is characterized as a bold and active species, following the fowler and carrying off his game as soon as it is shot. It is said to prey on partridges and other birds, and is very common at Hudson's Bay. We are also informed that this same species inhabits Denmark and Sweden, is frequent in all Siberia, and on the west side of the Uralian chain as far as the Volga. This species is very rare in Pennsylvania and the more southern parts of the United States. Its favorite range seems to be along the borders of the Arctic regions, making occasional excursions southwardly, when compelled by severity of weather and consequent scarcity of food. I some time ago received a drawing of this bird from Maine; that and another specimen which was shot in the neighborhood of Philadelphia are the only two that have come under my notice. Of their nest or manner of breeding we have no account."

With this sub-family we conclude the Rapacious Birds.

Order II. Passeres.

This order contains more birds than all the other orders together. It comprises all the birds which have feet especially formed for perching and a general organization enabling them to live amongst trees, in which a large majority of the species habitually pass their lives.

The claws are weak and not retractile as in the Accipitres, and the hind toe is not only upon the same plane, but is as much capable of grasp-

ing as are the others, by which character the birds of this order may at once be distinguished from any of the others, except the Scansores, in which, however, the arrangement of the toes in pairs is so peculiar that no chance of confusion exists.

The food of the Passeres consists principally of fruits or seeds and insects, the greater part of the species being omnivorous, or eating indiscriminately almost any description of these two classes of food which can be most readily obtained. There are many genera, however, the food of which is exclusively insects, and many others which never or rarely eat anything else than seeds; and others, again, which subsist almost entirely upon the pulp of fruits. All these, however, admit of classification, and will be regarded by us as constituting sub-orders or tribes.

The larynx, or organ of voice, is generally of complex structure in the birds of this order, which contains all that are commonly known as singing birds. There are few species which do not either sing or utter notes more or less musical, especially during the season of courtship; and even of those whose voices are harsh, some are frequently capable of being taught to imitate other sounds.

In this order the female is very generally smaller and less brilliant in her plumage than the male. They usually live in pairs, build mostly in trees, and frequently display great art in the construction of their nests.

We shall divide this extensive order into four sub-orders or tribes, viz.: Fissirostres, or split-billed birds, Tenuirostres, or slender-billed, Dentirostres, or birds with toothed bills, and Conirostres, or conic-billed birds.

Sub-Order 1. Fissirostres.

This is comparatively a small group when compared with the extensive sub-orders of Dentirostres and Conirostres. It comprises all the birds commonly known by the names of Swallows, Night-hawks, Kingfishers, Trogons, Bee-eaters, and some others of similar general characters.

The Fissirostres are generally distinguished by having the powers of flight developed to the highest degree. The beak is usually short, broad, and very deeply cleft, so that the opening of the mouth is very wide, or, as some of the old writers express it, they are very big in the swallow. Possessing this kind of bill they are adapted to capturing insects on the wing, receiving them into their mouths while in full flight. There are, however, some genera in which the characters of this group are not so strongly marked, and in which the bill is longer and stronger and the flight not so rapid nor long continued, but they all have the characteristic wide mouth.

These birds subsist almost entirely upon winged insects.

Fam. 1. Hirundinidæ, or Swallows. Bill small, much depressed, somewhat triangular; wings mostly very long, curved; tail various, frequently long and forked, sometimes short and truncate. Plumage compact, glossy; size small.

No birds are more universally or more favorably known than the swallows. Distributed through the entire globe, and usually conspicuous

on account of their numbers and rapidity of flight, they have found a place in the literature of all civilized people, ancient and modern.

These birds exhibit the social instinct to an extent rarely observable. Individuals of the same and sometimes of different species build their nests close together, and the birds themselves are almost constantly seen in flocks. They are very fond of frequenting the vicinity of the water, over the surface of which they may be seen skimming for hours. In fair weather they occasionally ascend to a great height in the atmosphere, but are usually occupied in the lower strata.

Although the species are small birds, the swallows are sought after as articles of food in some countries, to the neglect of those laws of common sense which would protect birds so useful in the destruction of hosts of diurnal insects, which are their only food. They are, however, generally protected by public sentiment and by special enactment in some of the states of North America. In Europe, also, they are generally much regarded; but in one country, Tuscany, they are placed directly beyond protection, being classed amongst those vermin which it is always lawful to destroy.

The swallows are eminently migratory, and show great regularity in their periods of departure and return. In the course of several years, some species will hardly vary more than a day or two in arriving at their nesting places from the south. Thus the Chimney bird (*Acanthylis pelasgia*) arrives in Pennsylvania from the 17th to the 20th of April; the Martin (*Progne purpurea*) from the 28th of March to the 5th of April; the Barn Swallow (*Hirundo rufa*) from the 9th to the 13th of April. These dates are of course subject to some variation from the different states of the weather, as, for instance, in case of a few days of severe cold or of a snow storm; but the mean results of the observations of several seasons show surprising uniformity.

Sub-fam. 1. *Hirundininæ, or House Swallows.* Head rather broad and depressed; bill short and more or less flattened and triangular, with the sides rather abruptly compressed towards the point, gape very wide. Wings long and pointed, first quill longest; tail usually forked; tarsi short; toes rather long and slender. Size small.

The true swallows are more beautiful in their plumage and more graceful in their movements than any other birds of this family. Several species occur in North America, the largest and most conspicuous of which is the Purple Martin, or House Martin, as it is frequently called from its sociable and familiar disposition (*Progne purpurea*). It is spread abundantly throughout the United States in the summer, spending the winter in South America. It is an universal favorite with the American population, and comes confidently to take possession of the little boxes or other habitations everywhere provided for its accommodation, as a sort of compensation for which it drives away all the hawks disposed to visit the establishment, destroys numerous insects injurious to vegetation, and, it may be added, if its box is near the house of its protector, is as good as an alarm clock to awaken him precisely at daybreak, by its incessant though not unpleasant chattering.

As the bluebird is the first to make its appearance in the spring and has the same partiality for a ready made domicil, the martin frequently finds himself anticipated and his right of possession stoutly resisted; he is, however, generally successful, though often not without a stubborn contest.

When forced to seek a habitation for himself, the martin selects a hollow tree, in which he constructs his nest, which, as is the case with most of the swallows, is formed principally of mud gathered from the neighboring ponds. The eggs are pure white.

The other species of American swallows may all be included in the genus *Hirundo*, although otherwise arranged by some naturalists.

The Cliff or Republican Swallow (*H. lunifrons*) is one of the most remarkable. A curious feature in the history of this bird is the fact that it has spread over the Atlantic States only at a late period. It has been long known in the valley of the Mississippi, but has only extended itself eastward within fifteen or twenty years. It was not until about 1840 that it was known in Pennsylvania except as a rare straggler, but it has since then become common, and in some districts abundant, hundreds being sometimes found nesting along the eaves of a single barn, which is a favorite locality. The nest is built entirely of mud, and is universally noticed on account of its singular shape, which is similar to that of a gourd, with the entrance at the smaller end and curved downwards. A lining of grass completes it, and three to five eggs are the usual contents.

The Barn Swallow (*H. rufa*) is the most common and best known species. The birds of this species build their nests in nearly all barns, or other large outhouses, in the Northern States, to which they can gain admittance, and it very rarely happens during the summer months that they are not observable in almost any landscape. This species is a great favorite.

The Swallow of Europe, *H. rustica* (*pl.* 103, *fig.* 7), is very similar to the common American species.

Another common species is the white bellied swallow (*H. bicolor*), though not so well known and constantly observed as the last.

The violet green swallow (*H. thalassina*), a species inhabiting the western slope of the Rocky Mountains, is the most beautiful of the American species. The bank swallow (*H. riparia*) derives its name from its predilection for streams of water, in the banks of which it excavates a hole and constructs its nest. The rough winged swallow (*H. serripennis*) has much the same habits, though it sometimes makes its nest in other places, such as the crevices in large walls, abutments of bridges, or the like.

Sub-fam. 2. *Cypselinæ, or Swifts.* Bill less flattened than the preceding, longer, and with the margins inflexed and somewhat gaping. Wings very long, curved; tarsi short; feet small and weak. Tarsi generally feathered; tail various, sometimes forked, often truncate. Size small.

A sub-family composed of numerous species of birds found in all parts of the world, and usually known as Swifts on account of their extraordinary rapidity of flight. The Chimney Swallow, or Swift of the United States (*Cypselus pelasgius*), is a good example of the birds of this group. It

arrives in the United States early in May, and is distributed throughout the entire Union. The birds of this species build their nests exclusively in unoccupied chimneys, for which they have, of course, abandoned the locations used by them prior to the introduction of chimneys into this newly settled country, previous to which memorable event they appear to have been quite content with such accommodations as were afforded by hollow trees. It is very remarkable, however, that these birds have, without any exception whatever, uniformly adopted the chimneys as fast as the settlement of the country has proceeded; and that, at this time, in the thickly populated Northern States, though this species is abundant, not a single pair have been observed to resort to the woods in many years. It is an exceedingly active little bird and a very fast flyer, and is known to the whole population of North America.

In Europe, two large species are found. They are about the size of the American purple martin, which is a namesake of the European species. The black martin of Europe (*Cypselus apus*) is very common, and, though so much larger, resembles the chimney swallow, though it builds its nest much like the swallows in old buildings or the crevices of rocks. The other species, the alpine martin, *C. melba* (*pl.* 103, *fig.* 8), is not so common, being restricted to the mountainous districts of the continent, where it makes its nest and rears its young.

The little birds which construct eatable nests are arranged here. They compose the genus *Collocalia*, and are among the smallest of the swallow family. The nests of several species are cooked in a great variety of styles by the Chinese and Japanese, and are highly esteemed.

Several species found in India (genus *Macropteryx*) are remarkable for beauty of plumage and gracefulness of form.

Fam. 2. Caprimulgidæ, or Goatsuckers. Bill very small and generally weak; gape very wide and extending beneath the eye. Tarsi and feet very short; toes long and sometimes strong. Plumage soft and loosely imbricated.

This extensive family of birds is well represented by the common Whip-poor-will and Night Hawk. It is composed exclusively of birds which like them prefer the twilight of the evening, or even the darkness of night, in which to pursue their prey or attend to the business of courtship and rearing their young.

The birds of this family are found in all parts of the world.

Sub-fam. 1. *Caprimulginæ, or Night Hawks.* Bill short and broad at base, with the gape extending under the eye, and furnished with a series of bristles on each side. Wings long and pointed: tail rather lengthened, mostly rounded, or sometimes deeply forked. Tarsi short and usually clothed with velvet-like feathers; toes long, the middle one of which is always armed with a serrated claw. Size small.

The species of this sub-family, which comprises the true *Caprimulgidæ*, are scattered over the entire globe, and, although not numbering many species, are yet sufficiently numerous in point of individuals to be universally known. They feed on moths and beetles, which they catch with

great dexterity on the wing in the dusk of the evening. They usually spend the day like the owls in the darkest recesses of the forest. Incubation is generally performed upon the ground ; no nest is constructed, but a dry, sheltered spot only selected, wherein two eggs only are deposited.

There is but one well established European species, which is the *Caprimulgus europæus*, and even it is not very common. It partakes exclusively of the general habits of its sub-family.

The species best known in North America is the Whip-poor-will, so called from its very remarkable note. "These notes," says Wilson, "seem pretty plainly to articulate the words which have been generally applied to them, *whip-poor-will*, the first and last syllables being uttered with great emphasis, and the whole in about a second to each repetition ; but when two or more males meet, their whip-poor-will altercations become much more rapid and incessant, as if each were striving to overpower or silence the other. When near, you often hear an introductory *click* between the notes. Towards midnight they generally become silent, unless in clear moonlight, when they are heard with little intermission till morning." A much larger species, the Chuck-wills-widow, so called also from its note, inhabits the southern part of the United States.

Many species of this sub-family are found in all parts of the world.

The common European species, *C. europæus* (*pl.* 103, *fig.* 6), resembles. to some extent, in general appearance and habits, the whip-poor-will, though it is almost without voice.

Sub-fam. 2. *Podarginæ, or Large Night Hawks.* Bill short, curved at the point, very strong, gape enormous ; base of the bill with projecting plumes, but without bristles. Tarsi and feet short, and comparatively weak ; tail rather long. Wings moderate. Size large.

These extraordinary birds are the largest of this family, many of the species being as large as the common crow. On account of the unusual broadness of their heads, and consequent wideness of their mouths and throats, they present a very grotesque and singular appearance.

The genus *Podargus*, which embraces the greater number of the species, is confined to Australia and some other of the most southerly islands of the Pacific ocean. In Australia the largest species (*P. cinereus*) lives in thick woods, venturing out on the wing only in the evening. It lives upon winged insects, and has been named by the colonists, in imitation of its note, "More pork." Another genus (*Batrachostomus*) is found in the interior of India.

In America the singular genus *Steatornis* is found. It contains one species only, which was discovered in caverns in South America by the celebrated Humboldt, and is remarkable for possessing a strongly hooked bill and other rapacious characters, showing a close affinity to the owls. It is said, however, to subsist upon fruits, and that it is eaten by the natives. Another American genus is *Nyctibius*, which contains several large species inhabiting South America, of which may be mentioned the *N. grandis*, a species as large as a hen.

Sub-fam. 3. *Podagerinæ.* Bill much depressed, with the culmen curved

and compressed on the sides to the tip, gape furnished usually with bristles or hairs. Wings long and pointed. Tail ample, sometimes long; tarsi short, partly covered, sometimes bare. Size small.

In this sub-family we arrange the American night hawks (*Chordeiles*), of which one species only inhabits the United States, although several others are found in Mexico and South America.

The long-shafted night jar of Africa (*Macrodipterix longipennis*), which belongs to this sub-family, is remarkable for having a plume, which is sometimes five times the length of its body growing out of each wing. This gives the bird, especially when flying, a very curious appearance, and its use is entirely unknown. Several species of another genus (*Podager*) are found in South America.

Fam. 3. Coraciadæ, or Rollers. Bill more or less lengthened and broad at base, compressed, with the tip hooked; wings long and powerful; tail rather short, but with the two external feathers frequently much lengthened; tarsi and feet short.

A family composed of a few birds strictly confined to the Old World. They are all remarkable for beauty of plumage and elegance of form.

Sub-fam. 1. *Coracianæ, or Rollers.* Bill moderate, straight, upper mandible slightly longer; nostrils basal, oblique, linear. Wings moderate, pointed; tail long, wide, with the lateral feathers frequently lengthened; tarsi short; gape wide. Size moderate. All the species with gay colored plumage.

This is a small sub-family of beautiful birds which are found in Africa, Asia, and the larger Pacific islands. Their plumage is almost invariably of brilliant colors, and usually contains more or less green or blue of the richest hue. One species occasionally visits Europe, *Coracias garrula* (*pl.* 99, *fig.* 3), where it is much sought after by collectors as one of the few bright plumaged European species. The most common species in collections is the Bengal roller (*C. bengalensis*), skins of which are brought abundantly from India, where it is common. The food of the rollers consists of both fruits and insects, the latter of which they catch after the manner of the flycatchers.

Sub-fam. 2. *Todinæ, or Todies.* Bill lengthened, much flattened, slightly compressed towards the tip, which is rounded; nostrils lateral with the opening exposed. Wings short and rounded; tail moderate, emarginated. Tarsi long, slender; toes moderate. Size small.

A sub-family consisting of a few small birds found in tropical America. They are represented as being dull and stupid little birds, living upon grasshoppers and other insects, and partaking much of the habits of some of the flycatchers. The most common species is the *Todus viridis*, which is a beautiful green bird with a scarlet throat. It is said to construct a curious bag-shaped nest, composed of wool and with a narrow entrance.

Sub-fam. 3. *Eurylaiminæ, or Boatbills.* Bill large and extremely broad at base, curved and gradually compressed to the tip; nostrils lateral, exposed; wings moderate; tail moderate; tarsi short. Size small.

India is the country of this sub-family. It contains a few species only

of handsome birds, with remarkably wide and strong bills which are said to be used in the capture of coleopterous insects, upon which these birds subsist. No one of the species is very common in collections, though the *Eurylaimus nasutus* is frequent. It lives in the retired and shaded jungles, where it constructs a pendent nest, usually in the neighborhood of the water.

Sub-fam. 4. *Momotinæ, or Motmots.* Bill long, elevated, and broad at the base, with the sides compressed, and the margins serrated. Wings short, rounded; tail long, graduated, with the two middle feathers usually much the longest, and generally with their shafts bare for a considerable distance; tarsi and feet moderate. Size moderate, much larger than either of the two last sub-families; colors brilliant.

This is a sub-family consisting of some twelve or thirteen species of beautiful birds, which are restricted to the warmer parts of America. They prefer the shades of the forest, but seem occasionally to frequent deserted or dilapidated buildings. They feed indiscriminately upon fruits, snakes, lizards, and insects, which are taken with the point of the bill and tossed upwards to be caught in the extended mouth. It is said that they also rob the nests of other birds. The Brazilian motmot (*Momotus brasiliensis*) is the most common species, being very abundant in Brazil and other countries of South America. Several species have been found in Mexico and the West Indies.

Fam. 4. Trogonidæ, or Trogons. General form stout, but rather graceful. Bill short, strong, broad at the base, with the tip hooked; nostrils basal generally, and concealed by the projecting feathers. Plumage very beautiful.

This family is composed of a few genera of handsome birds, most numerous in tropical America and Asia, one species alone having been found in Africa.

Sub-fam. 1. *Trogoninæ, or true Trogons,* of America. Bill short, strong, with the base very broad and nostrils concealed; wings short; tail ample, sometimes long; tarsi short and feathered; plumage of the head frequently elongated and crest-like. Colors brilliant metallic green and red.

These splendid birds are peculiar to tropical America. They are represented by travellers as solitary and quiet birds, remaining within the dense foliage of the tropical forests, and feeding upon both fruits and insects. Beetles are their favorite food, upon which as well as berries they dart in the manner of swallows. Incubation is performed in hollow trees, in which no nests are built, but the eggs are laid upon the bare wood.

About thirty species of the Trogons are known to inhabit South America and Mexico, all of which possess much beauty of plumage; but there is a small genus (*Calurus*) remarkable for the great length of the upper tail-coverts, which are amongst the most splendid of birds. The *C. resplendens* is a species found in Yucatan, and is the bird alluded to by Stephens as having been considered sacred by the ancient inhabitants of that country. It has the tail-coverts developed to several times th length of its body, and the whole plumage of the most beautiful metallic green

imaginable. Another species, *C. auriceps*, is common in the north of Brazil, and in addition to the beautiful green of the plumage of its body, it has the head of splendid golden, almost appearing to be gilded artificially. The genus Trogon, *T. viridis* (*pl.* 97, *fig.* 7), and the Curucui, *T. curucui* (*pl.* 97, *fig.* 6) are common in collections.

Sub-fam. 2. *Harpactinæ, or Asiatic Trogons.* Bill stronger than in the preceding, both mandibles notched at their tips; nostrils partially covered; tarsi slightly feathered, short; anterior toes united. Colors gay, usually brown or reddish, fulvous, and scarlet.

India and the Malay Archipelago are the countries of the birds of this sub-family. They are showy, but not so splendid as their American relatives, though they appear to be very similar in all other respects. They are usually noticed sitting quietly on a dead tree, occasionally darting after an insect and returning to the same position, or wandering about from tree to tree. *Harpactes malabaricus, rutilus*, and *diardii*, are amongst the most common species; while one large species, *H. gigas*, well established as having been known to the older ornithologists, is unknown in modern collections.

One species only, which constitutes a genus of its own, has been found in South Africa; it is the *Apaloderma narina*, and it appears to differ in no respect from the general characters of the Trogons.

Fam. 5. Alcedinidæ. General form, short, thick, and strong. Bill long, and mostly adapted to striking as well as seizing their prey. Wings generally moderately strong; tail generally short; tarsi short; toes long.

A very extensive family, composed of the kingfishers, puff-birds, and jacamars, distributed amongst a large number of genera. They inhabit all parts of the world, and far the greater part show a disposition to frequent the vicinity of water.

Sub-fam. 1. *Bucconinæ, or Puff-birds.* Bill rather long, elevated, and broad at the base, with the tip curved and frequently emarginated or fissured. Wings mostly rather short; tail moderate; tarsi short, covered with scales. Size various, never large; plumage plain.

The birds of this sub-family derive their name from the habit of raising or puffing up their profuse plumage, which, it appears, is more or less the case in all the species. Southern America is their native country, and their habits appear to be very similar to those of the birds of the last sub-families. They live upon coleopterous and other insects, which they capture upon the wing.

Bucco macrorhynchus (*pl.* 97, *fig.* 8) is the best known species. *Monasa tranquilla* and *leucops* are, however, common in collections of South American birds.

Sub-fam. 2. *Halcyoninæ, or Broad-billed Kingfishers.* Bill broad, long, and nearly quadrangular, with the lateral margins straight, or curved slightly upwards. Wings broad, short, and rounded; tail moderate; tarsi very short, robust. Size various; plumage generally containing more or less blue and green colors.

This sub-family may be said to comprise the kingfishers which frequent

salt water. All parts of the world, except America, are inhabited by these birds. Australia produces a genus (*Dacelo*) which contains the largest species of this sub-family. They feed upon small quadrupeds, reptiles, insects, and other animals, and are remarkable for a peculiar gurgling laugh, from which the colonists have named the commonest species "the laughing jackass."

The genus *Halcyon* comprises about fifty species, which are mostly found in Africa and India, and the islands of the Indian and Pacific oceans. These birds live exclusively in the immediate vicinity of the water, from the animals inhabiting which they derive their subsistence.

The black-capped kingfisher of India, *H. atricapilla* (*pl.* 103, *fig.* 3), is one of the most common species, though many others are common in collections. The birds of this group are said to nestle in hollow trees.

Sub-fam. 3. *Alcedininæ, or Narrow-billed Kingfishers.* Bill very straight, compressed, and sometimes slender, points of both mandibles acute, commissure straight. Wings and tail short; tarsi very short, but robust; toes very unequal, the two anterior of which are united. Size small; colors of plumage more or less blue and green.

The birds of this sub-family, though not constituting so many species as are contained in the preceding, are more generally diffused over the entire surface of the temperate and torrid zones. They may be considered as the fresh-water kingfishers in distinction from the *Halcyonidæ*, as they are found only in the vicinity of rivers or small streams, upon the fishes inhabiting which they live. In the banks of those streams these birds excavate holes, frequently of considerable depth, in which they construct their nests and rear their young.

The common European kingfisher, *Alcido ispida* (*pl.* 103, *fig.* 5), belongs here. It is a very pretty little species, found sparingly throughout the continent, inhabiting the banks of small streams, and usually seen perched upon a small bough overhanging the stream, whence it darts upon such fishes as expose themselves to its keen vision. About twenty other species, more or less related generically to the common European species, are found in Asia and Africa. Some species of the latter country are quite diminutive, being not larger than the North American wren.

All the American kingfishers belong to the genus *Ceryle*, which contains, however, species from other parts of the world. There are about ten American species, the only one of which found in the United States is the common belted kingfisher (*C. alcyon*). This bird is distributed throughout the United States, and being the only species of its kind found in the north is universally known. It is constantly to be seen along the courses of brooks or creeks, ready to seize upon the small fishes which are its favorite food. The nest is constructed in a hole in the bank of the stream, and this species is said to breed for several successive years in the same nest.

Several species have been found as far north as Mexico, though they are all common in South America. The *C. amazona* is one of the most common, and has very handsome silky green plumage; others have, however, much the same. The giant kingfisher of authors (*C. torquata*) is

one of the largest of this family, and appears to be common in Brazil; while the little American kingfisher (*C. americana*) is one of the smallest. It also is found abundantly in South America, and has recently been discovered in Texas. Several species are known to inhabit Mexico, and some large species inhabit India and Africa. The great Java kingfisher, *C. javanicus* (*pl.* 103, *fig.* 4), is one of the most common.

Sub-fam. 4. *Galbulinæ, or Jacamars.* Bill very long, straight, and pointed, greatly compressed, culmen sharp; wings short; tail more or less lengthened, and usually graduated. Tarsi short, feathered; feet weak; toes usually two before and two behind. Size small; plumage usually brilliant metallic green.

A sub-family, composed of about a dozen species of brilliantly colored and peculiar looking little birds, exclusively confined to South America and the West Indies. They inhabit damp places in the forests, and are said to subsist entirely upon insects, which they devour after having divested them of their wings and other hard parts. These birds breed in holes in trees or in the banks of streams in the manner of kingfishers.

Several species are common in collections: they are the green jacamar (*Galbula viridis*), the white-bellied jacamar (*G. albirostris*), and others. One of the most beautiful is the largest species known; it is called the grand jacamar, and is found in the interior of South America, though nothing respecting its history or habits has been reported by travellers.

A recently discovered species of this sub-family, a very modest and unpresuming bird apparently, is remarkable for having had given to it one of the longest of ornithological names, *Jacamaralcyonides leucotis.*

Fam. 6. Meropidæ, or Bee-eaters. A family composed of birds exclusively inhabiting the warm regions of the Old World, and universally known by the name of "bee-eaters." They form one sub-family only, as below.

Sub-fam. Meropinæ. Bill long, curved, slender and pointed, compressed. and with the tip very acute; wings long, pointed, secondary quills emarginated; tail long, broad, usually with the two middle tail feathers longest. Tarsi short, strong; toes long; claws moderate. Size small; plumage generally green.

This sub-family contains about forty species of birds found almost exclusively in Asia and Africa. They are migratory in their habits, and one species occasionally visits northern and central Europe; it is the common bee-eater (*Merops apiaster*). All the species are said to subsist entirely upon insects, which they catch upon the wing with great dexterity, and in pursuit of which they skim over the surface of the ground like swallows. Nearly all the species are handsome little birds with green and yellow plumage, and several are very commonly brought from India and Western Africa. The Indian species usually met with are the green bee-eater (*Merops viridis*) and the Java bee-eater (*M. javanicus*); from Africa we frequently have the swallow bee-eater (*M. hirundinaceus*), the red-throated bee-eater (*M. ruficollis*), and many others. One species has been discovered in Australia, *M. ornatus.*

Sub-Order 2. Tenuirostres, or Slender-billed Birds.

Bill always slender, generally long and curved; tongue usually with a fascicle of slender hair-like filaments at the point. Size generally small. This tribe contains the smallest of all birds.

The length and slenderness of the bill are the peculiar characters of this group, which is composed of birds found in all parts of the world. Nearly all the species are supposed to derive their subsistence, in a measure, from the nectar of flowers, though it is quite certain that very many of them capture small winged insects also. There is scarcely a species in this group which does not possess elegance of form and beauty of plumage.

Fam. 1. Upupidæ, or Hoopoes. Bill lengthened, slender, generally curved, compressed; wings long, rounded: tail generally long and ample; tarsi generally strong and short; feet strong. Size rather large.

A family containing some of the most magnificent of birds. They are restricted to the old world, and are said to feed upon succulent fruits and the juices of flowers.

Sub-fam. 1. *Upupinæ, or Hoopoes.* Bill lengthened, slender, and greatly compressed. Wings and tail more or less long and rounded; tarsi strong and usually short; toes long, strong, claws strong and curved. Size rather large, generally crested.

The species of this sub-family are restricted to the old world. The Hoopoe of Europe (*Upupa epops*) is its representative in that continent. It derives its name from its note, and is very common in the south during the summer.

There are several other species of Hoopoes inhabiting Africa and India.

In Africa is also found the genus *Irrisor*, which belongs here, composed of a considerable number of very handsome dark plumaged birds, generally of elegant form and with long graceful tails. They are found throughout the entire continent of Africa and live in trees, creeping among the branches in search of insects, which with fruits compose their food. They roost and breed also in the holes of trees. *Irrisor erythrorhynchus* and *melanorhynchus* are the most common species. Several species are found in Liberia and other countries of Western Africa.

Sub-fam. 2. *Epimachinæ, or Plumed Birds.* Bill long, rather strong, curved margins obtuse and tip acute; wings moderate, rather rounded; tail various, generally even or graduated. Tarsi more or less strong, long, and usually covered with scales; toes long and strong, hind toe armed with a strong claw. Size rather large. Colors dark in the males and very beautiful.

Nearly all these beautiful birds are found in the island of New Guinea, one species only in New Zealand, and one in Australia. Though long known to naturalists, and known also extensively on account of the trade in their skins, which the natives of New Guinea have maintained for centuries, their habits and history are entirely unknown. The *Epimachus superbus* is common in collections, and is frequently met with in ornamental cases of stuffed birds. It has very fine, black, velvet-like plumage, with a curious breast-plate, or rather apron, of detached feathers, which are

of splendid metallic green. Amongst traders these are usually confounded with the Paradise birds. *Epimachus magnificus* and *resplendens* are other very beautiful species.

Sub-fam. 3. *Paradiseinæ, or Paradise Birds.* Bill strong, slightly curved only, compressed, tip notched; wings moderate, rounded; tail various; tarsi and feet strong, sometimes short; toes long; strong claws, curved and acute. Sides of the body, breast, tail, and sometimes the head, generally with long and very ornamental plumes. Size rather large.

The Paradise birds are, perhaps, the most beautiful of birds. They are peculiar to the large island of New Guinea, in the forests of which they live on the tops of the highest trees, and subsist upon fruits and insects. It is said that they have loud and unpleasant notes, somewhat like those of the crow family; but little is known, however, of their history.

The greater and lesser Birds of Paradise, *Paradisea major* and *minor* (*pl.* 99, *fig.* 4), are the species most common in collections, though the king paradise bird, *P. regia* (*pl.* 99, *fig.* 5), is frequent. The other known species are, the red-plumed (*P. rubra*), the magnificent (*P. magnifica*), the superb, *P. superba* (*pl.* 99, *fig.* 6), the six-shafted, *P. sexsetacea* (*pl.* 99, *fig.* 7), so called from the curious appendages of that number growing from the sides of its head, the republican (*P. respublica*), and Wilson's paradise bird (*P. wilsonii*). From the two first species (the greater and lesser paradise birds) the plumes worn in ladies' head-dresses are obtained, and their skins have been articles of merchandise for centuries.

FAM. 2. NECTARINEADÆ, OR SUN BIRDS. Bill more or less lengthened, slender, and curved; wings generally short and incapable of long-continued flight; tail usually moderate, generally short and truncate, sometimes long and graduated. Tarsi and feet moderate, generally rather weak.

A very numerous family of birds, nearly all of which are of very small size and distinguished for brilliancy of plumage, in which they are only excelled by their immediate relatives, the humming birds. The species are most abundant in Asia and Africa.

Sub-fam. 1. *Nectarininæ, or Sun Birds.* Bill slender, curved, compressed, and with the tip entire, acute; nostrils basal, with the opening closed by a membrane. Wings moderate, rounded; tail generally lengthened, but frequently truncate. Tarsi usually moderate or weak. Size small; colors of plumage usually metallic and very showy.

This sub-family consists of about one hundred and fifty species of beautiful little birds, which are restricted to the tropical countries of Asia and Africa, and are known by the universal name of sun birds, though the American colonists of Western Africa call them humming birds. They are usually seen in pairs or in small flocks, and fly with a tremulous or humming noise like the humming birds, which in most respects they appear to resemble. They feed principally upon minute insects, and are said to be fond of spiders, for which they search in the crevices of the bark of trees. Many species are found in Liberia, some of which are exceedingly beautiful, such as the Senegal sun bird (*Nectarinia senegalensis*), the red-backed sun bird (*N. cuprea*), and many others.

A variety of species inhabit India, of which the most common appear to be the *N. zeylonica, mahrattensis*, and others.

Sub-fam. 2. *Cœrebinæ, or American Creepers.* Bill generally rather short, wide at the base, curved or sometimes nearly straight, sides compressed. Wings long and pointed; tail short, usually even; tarsi short; feet moderate. Size small. Colors usually blue or green and showy.

A sub-family of beautiful little birds peculiar to South America, said to feed upon the minute insects which frequent expanded flowers, about which they are observed to fly in the manner of humming birds. Their nests are suspended from the branches of trees, pear-shaped, composed of grass and woody fibres woven together, and with a tubular entrance from below. This mode of construction warrants security from monkeys, serpents, or other depredators.

There are about twenty species of these birds, the most common of which are the *Cœreba cyanea* (*pl.* 102, *fig.* 9) and *cœrulea*, the *Dacnis spiza*, a beautiful green bird with a black head, and the *Certhiola flaveola*.

Fam. 3. Trochilidæ, or Humming Birds. Bill generally long, very slender, usually curved but sometimes straight, with the lateral margins of the upper mandible dilated. Wings generally long and flattened in a peculiar manner; tail usually ample, truncated or cuneated; tarsi and feet usually very small and weak. Size very small.

The most diminutive birds in existence, and among the most beautiful. Swainson gives the following description in Lardner's Cyclopædia, Birds II. page 146, in his usual forcible and pleasant manner. "In speaking of these charming birds, the naturalist is almost tempted to abandon that didactic style best suited to his subject, and to clothe his information in the language of poetry; yet both must fail in conveying to the mind an adequate idea of their surpassing beauty. The rainbow colors of the most resplendent gems are here superadded to a living form which in itself is exquisitely graceful and animated in all its movements. The flight of these pigmy birds is so rapid as to elude the eye; for a few moments they may be seen hovering over a flower, but as soon as they have supped its sweetness they vanish in an instant; they may, in truth, be said to 'come like shadows, so depart.'"

This celebrated family of birds is exclusively American and very numerous, there not being less than three hundred species now known, to which almost every traveller in South America yet makes additions.

Sub-fam. 1. *Grypinæ, or Wedge-tailed Humming Birds.* Bill long, slender, and curved throughout its length; culmen of the upper mandible distinctly keeled, tip acute, lateral margins dilated and overlapping the under mandible; wings long and pointed; tail long, broad, and generally cuneated; tarsi short and very slender. Colors generally plain, not metallic.

About thirty birds compose this sub-family. They are very distinct from the other sub-families of Humming Birds, and are nearly all remarkable for their plain plumage and long tails. They inhabit all parts of South America, but one genus (*Oreotrochilus*, Gould) contains species which are found only in the Andes, immediately below the line of perpetual snow.

Sub-fam. 2. Trochilinæ, or true Humming Birds. Bill usually long, straight, or slightly curved, and very slender; wings long, pointed; tail various, generally truncate, sometimes rounded; tarsi and feet very short and weak; toes long and slender. Size small; plumage more or less metallic and very beautiful.

This sub-family contains about one hundred species of humming birds, amongst which are some of the most beautiful little birds in existence. The mango (*Trochilus mango*), the swallow-tailed (*T. macrourus*), the emerald (*T. glaucopis*), the long-tailed Jamaica humming bird (*T. polytmus*), a magnificent species, the topaz (*T. pella*), the evening humming bird (*T. vesper*), and many other splendid species belong here.

They are exclusively restricted to South America and the West Indies, except the Mango, which has been found in Mexico and may be classed as a North American bird.

The ruby topaz, *T. moschitus* (*pl.* 99, *fig.* 8), a splendid and common species, the magnificent *T. ornatus* (*pl.* 99, *fig.* 9 *a*), De Lalande's humming bird, *T. delalandii* (*pl.* 99, *fig.* 10), and some others, are common in collections. The crested humming bird, *T. cristatus* (*pl.* 99, *fig.* 12), and the smallest humming bird, *T. minimus* (*pl.* 99, *fig.* 11), are more rare. The latter is the smallest of all known species.

Sub-fam. 3. Mellisuginæ, or straight-billed Humming Birds. Bill usually lengthened, slender, and straight; wings long, pointed; tail various, mostly truncate, sometimes with the two middle feathers or the two external feathers long; tarsi and feet short and weak. Colors usually very brilliant.

The species of this sub-family are diffused over the entire tropical and temperate regions of America, though the much larger portion of them exclusively inhabit the southern countries of this continent.

The common humming bird, *T. colubris* (*pl.* 99, *fig.* 9 *b*), belongs here, and is the only species the history of which is well known. It appears in the northern part of the United States from the beginning to the middle of May, and was observed by Dr. Richardson in the fur countries of the north, bordering upon the Arctic circle. The nest is built upon the projecting branch of a tree, and is very artfully constructed and covered with moss or with lichens, giving it much the appearance of a knot upon the branch where it is located. Within are laid copious quantities of the *pappus* or down of plants, forming a soft and very suitable bed for the reception of the diminutive eggs. These are generally two only, and are hatched in the short space of ten days.

One of the most remarkable qualities of this little bird is its great pugnacity: the male does not hesitate to attack other birds much larger than himself, and has even been known to challenge the king-bird or the martin, the latter of which he sometimes compels to retreat. To man this bird shows little aversion, quietly hovering around its favorite flowers when so nearly approached as almost to be caught in the hand. It frequently enters at the windows of houses and is caught. Both old and young are soon reconciled to confinement. In a very short time they will feed freely upon diluted honey, or sugar and water, and suffer themselves to be

approached, or even touched, without showing signs of alarm. The male only of this humming bird has the brilliant gorget on the throat.

Several other species have been observed as far north as California, of which we may mention the Anna humming bird (*T. anna*) and the rufous humming bird (*T. rufus*).

The latter is supposed to proceed on the western side of North America nearly to the region of perpetual ice. It is abundant on the Columbia river, and was observed by the celebrated naturalist Nuttall, engaged in the duties of incubation, in the latter part of May. "The female was sitting upon two eggs of the same shape and color as those of the common species. The nest was also similar, but somewhat deeper, made of the same downy substances, and coated with lichens. At my approach the female came hovering round the nest; and soon after, when all was still, she contentedly resumed her place."

There are from one hundred and fifty to two hundred species of humming birds in this sub-family, nearly all of which, we may say, are confined to South America. Several very handsome species are, however, known to inhabit Mexico.

The giant humming bird (*T. gigas*) is arranged here. It is the largest species known, being nearly as large as the orchard oriole. The sword-billed humming bird is worthy of being mentioned on account of its excessively long bill, which considerably exceeds the length of its body. It feeds upon insects which frequent the flowers of Bignonia (trumpet flowers) and other plants which have very large tubular flowers, for which its bill is admirably adapted. The white-necked humming bird, *T. albicollis* (*pl.* 102, *fig.* 1), is a common species.

The birds of this sub-family seem to prefer the northern parts of South, and probably will be discovered to be numerous in Central America.

Fam. 4. Meliphagidæ, or Honey-suckers. Bill generally long, curved, and acute, tip sometimes emarginate; wings moderate or rounded; tail mostly long and broad; tarsi rather short and strong; toes long. Tongue extensile and furnished at the tip with a fascicle of short, slender fibres.

A small family of birds, peculiar to Australia and the adjacent islands.

Sub-fam. 1. *Myzomelinæ, or Honey-creepers.* Bill long, slender, and curved; wings short; tail short and emarginate; tarsi and feet moderate, rather slender; claws curved, acute.

These are observed to frequent the flowers of various species of plants indigenous to the continent of Australia, and are represented as feeding upon their secretions as well as upon the small insects which abundantly infest them. Whilst occupied in this pursuit, they may be seen clinging to and hanging from the flowering branches in a variety of attitudes. Their flight is rapid, and occasionally at a considerable height in the air. These birds are not common in collections. *Myzomela sanguinolenta*, *Glyciphila melanops*, and some others are, however, frequently brought by travellers and collectors.

Sub-fam. 2. *Meliphaginæ, or Honey-eaters.* Bill long, slender, and usually acute; wings moderate, rounded; tarsi short, strong; toes moderate, sometimes strong; claws curved, acute.

This sub-family is composed of nearly one hundred birds, the majority of which are restricted to Australia, and much resemble the preceding in general characters and habits. In addition to the food of the birds of that sub-family, some of the species of the present eat berries and other fruits.

The *Tropidorhynchus corniculatus* is one of the best known species of Australian birds. It has received from the colonists the significant but not very poetical name of "Leather-head," from the baldness of the part alluded to.

About a dozen species, constituting the genus *Phyllornis*, which are arranged here, inhabit Java and other islands of the Indian Archipelago. They are mostly clothed in plumage of a beautiful green or blue color, and appear to be abundant in those localities.

Sub-fam. 3. *Melithreptinæ.* Bill short, somewhat conic, compressed towards the tip, which is curved; wings more or less long; tarsi short and strong; toes long; claws moderate.

A group of about twenty birds, strictly peculiar to Australia. Their habits and manners appear to be very similar to those of the preceding sub-families, though they appear to be more insectivorous. For the purpose of capturing insects they frequent flowering plants, and occasionally are observed on the ground in the pursuit of beetles and other similar insects. The *Psophodes crepitans*, which belongs here, is one of the common birds brought in collections from Australia.

Fam. 5. Certhiadæ, or Creepers. Bill long, slender, more or less curved; nostrils small; wings usually short and rounded, sometimes rather pointed. Tail various, frequently terminated in abrupt points; tarsi and feet generally rather strong.

These are the Creepers, Nuthatches, &c., some species of which inhabit the northern, but the much larger portion the southern regions of the globe. They are generally of small size, and resemble, in some respects, the scansorial birds (woodpeckers, &c.).

Sub-fam. 1. *Furnarinæ, or Oven Birds.* Bill rather long, curved, frequently compressed; wings short, rounded; tarsi and feet strong; toes long. Tail broad, rounded, the feathers of which are frequently terminated in soft points.

This sub-family consists of about thirty birds, which have obtained the name of oven birds from their constructing nests somewhat of the shape indicated by the name, which are generally built in an exposed situation, as on the dead branch of a tree, or sometimes in the immediate neighborhood of houses or other buildings. When finished, it has the appearance of an oven several inches in diameter, with the entrance in the side. There are, however, several species of this sub-family which construct nests of the ordinary description, and some which live almost exclusively upon the ground, and make their nests in holes.

The birds here classed are exclusively found in South America and the West Indies. *Furnarius rufus*, *Lochmias squamatula*, and some others, are common species.

Sub-fam. 2. *Synallaxinæ, or Sharp-tailed Creepers.* Bill rather short and strong; frontal feathers rather rigid. Wings very short and rounded; tail broad, more or less lengthened, and usually graduated or cuneated, with the tips of the feathers lanceolate. Tarsi and feet large and strong; claws acute.

Another sub-family of birds peculiar to South America and Mexico, and which partake of the general characters of the last mentioned. They are generally plain colored little birds, somewhat resembling wrens in general appearance.

Sub-fam. 3. *Dendrocolaptinæ, or Long-billed Creepers.* Bill usually long and curved, compressed; wings moderate, generally rounded; tail long, broad, and graduated, with the feathers ending in hard points. Tarsi and feet strong; claws large and acute.

This sub-family is also essentially South American. About forty species are classed in it, which much resemble those of the two preceding sub-families, but differ from them in being larger and having longer bills. The greater part of the species inhabit the vast forests of South America, and appear to have somewhat the habits of woodpeckers. In one genus (*Xiphorhynchus*, or sword-bills) the bill is exceedingly long. The Cayenne creeper (*Dendrocolaptes cayennensis*) and the white-throated creeper (*D. albicollis*) are commonly met with.

Sub-fam. 4. *Certhianæ, or Creepers.* Bill rather long, slender, curved; wing rather long; tail lengthened, graduated, the feathers of which are slightly rigid. Tarsi and feet slender; claws moderate. Size small.

Although not comprising more than a dozen species, the birds of this sub-family are found in all parts of the world. They are very active and shy little birds, subsisting upon minute insects, which nearly all the species search for in the crevices of the bark of trees, after the manner of woodpeckers.

The *Certhia familiaris*, or the brown creeper (*pl.* 102, *fig.* 2), is frequently met with in the forests of Europe and North America. It much resembles, in general character, the small woodpeckers and nuthatches with which it constantly associates in the forest, though it is much smaller, being, next to the golden-crested wren, the smallest of European birds. In the United States it is not so common as in Europe.

The rock creeper (*C. muraria*) of Europe also belongs here. It is found exclusively in the mountains of Europe and Asia, and is usually observed flitting from one projecting rock to another, in search of spiders and other insects, of which its food consists.

One genus (*Climacteris*) of this sub-family is peculiar to Australia, the birds of which inhabit the woods and partake of the general characters of the others with which they are classified.

Sub-fam. 5. *Sittinæ, or Nuthatches.* Bill rather short, very straight, more or less cylindrical; wings long and pointed; tail very short; tarsi and feet rather long and slender. Size small.

The nuthatches, though numbering scarcely more than twenty species, are scattered over the whole world. Several species inhabit North America,

and are usually known by the name of "Sapsuckers," and one species is common in Europe (*Sitta europæa*).

The most common species of the United States is the white-breasted nuthatch (*S. carolinensis*), which is a very familiar and favorite little bird, living throughout the year in the same district, and, in fact, is supposed to ramble but little from the woods in which it was born. Its habits are very similar to those of the small woodpeckers, being seen constantly creeping on the surface of limbs and trunks of trees. So secure is its foothold, that it creeps equally well with its head upwards or downwards upon the tree, and is said to roost with the same indifference to position. It frequently in the winter approaches the precincts of dwellings or out-houses, and picks up whatever of insect or other suitable food it can discover.

Two smaller species are occasionally met with in the United States, the red-bellied and the brown-headed nuthatches (*S. canadensis* and *pusilla*). They entirely resemble in habits the common species. Another and still smaller species (*S. pygmea*) is found in California.

Some six or eight species of these little birds are peculiar to Australia and New Zealand.

Sub-fam. 6. *Troglodytinæ, or Wrens.* Bill more or less long and slender, usually slightly curved and somewhat compressed; wings short and rounded; tail various, generally rounded; tarsi long and slender; toes long, rather slender. Size various, generally small. Colors plain.

There are about fifty species of the true wrens, which inhabit all parts of the world except Africa. In America, they are more numerous than elsewhere, and are well represented by that universal favorite the house-wren of the United States (*Troglodytes ædon*), the history of which by the incomparable Wilson we beg leave to extract: "This well known and familiar bird arrives in Pennsylvania about the middle of April, and about the 8th or 10th of May begins to build his nest, sometimes in the wooden cornicing under the eaves or in a hollow tree, but most commonly in small boxes fixed on the top of a pole, in or near the garden, to which he is extremely partial, for the great number of caterpillars and other larvæ which it constantly supplies him. If all these conveniences are wanting, he will even put up with an old hat, nailed on the weatherboards, with a small hole for entrance; and if even this be denied him he will find some hole, corner, or crevice about the house, barn, or stable, rather than abandon the dwellings of man. In the month of June a mower hung up his coat, under a shed near the barn, and two or three days elapsed before he had occasion to put it on again; thrusting his arm up the sleeve, he found it completely filled with some rubbish, as he expressed it, and on extracting the whole mass found it to be the nest of a wren completely finished and lined with a large quantity of feathers. In his retreat he was followed by the little forlorn proprietors, who scolded him with great vehemence for thus ruining the whole economy of their household affairs. The twigs with which the outward parts of the nest are constructed are short and crooked, that they may the better hook in with one another; and the hole or entrance is so much shut up, to prevent the intrusion of snakes or cats, that it appears

almost impossible the body of the bird could be admitted; within this, is a layer of fine dried stalks of grass, and lastly feathers. The eggs are six or seven, and sometimes nine, of a red purplish flesh color, innumerable fine grains of that tint being thickly sprinkled over the whole egg. They generally raise two broods in a season, the first about the beginning of June, the second in July.

"This little bird has a strong antipathy to cats; for having frequent occasion to glean among the currant bushes and other shrubbery in the garden, those lurking enemies of the feathered race often prove fatal to him. A box fixed up in the window of the room where I slept, was taken possession of by a pair of wrens. Already the nest was built and two eggs laid, when one day the windows being open, as well as the room door, the female wren venturing too far into the room to reconnoitre, was sprung upon by grimalkin, who had planted herself there for the purpose, and before relief could be given was destroyed. Curious to see how the survivor would demean himself, I watched him carefully for several days. At first he sang with great vivacity for an hour or so, but becoming uneasy, went off for half an hour; on his return he chanted again as before, went to the top of the house, stable, and weeping-willow, that she might hear him, but seeing no appearance of her, he returned once more, visited the nest, ventured cautiously into the window, gazed about with suspicious looks, his voice sinking to a low melancholy note, as he stretched his little neck about in every direction. Returning to the box, he seemed for some minutes at a loss what to do, and soon after went off, as I thought, altogether, for I saw him no more that day. Towards the afternoon of the second day, he again made his appearance accompanied by a new female, who seemed exceedingly timorous and shy, and who, after great hesitation, entered the box. At this moment the little widower, or bridegroom, seemed as if he would warble out his very life with ecstasy of joy. After remaining in about half a minute, they both flew off, but returned in a few minutes, and instantly began to carry out the eggs, feathers, and some of the sticks, supplying the place of the two latter with materials of the same sort, and ultimately succeeded in raising a brood of seven young, all of which escaped in safety."

Several other species of wrens inhabit America, most of which live in the woods and do not partake of the sociable character of the house-wren. The European wren is of the same description in some measure as the latter, though it builds its nest in low bushes near the ground. It does not appear to be so great a favorite as the American house-wren.

In this sub-family the lyre bird of Australia, *Menura superba* (*pl.* 102, *fig.* 14), is classed. It is remarkable for the singular beauty of its long tail. Australia is its peculiar country, in which it appears to prefer the woods upon the sea-coast, though it has been met with in those of the interior, living habitually upon the ground, and constructing its nest upon a projecting rock, or the stump of a tree. Its food consists of insects which are obtained by scratching amongst the fallen leaves.

Several genera, comprising about forty species, of the birds of this

sub-family, are peculiar to South America. They all resemble to a greater or less extent the wrens with which we are familiar, though some species live almost exclusively upon the ground. There is one genus (*Hylactes*) the species of which are remarkable for very robust legs and feet. *H. rufus* is the best known species.

Sub-Order 3. Dentirostres, or toothed-billed Birds.

This group embraces an immense number of birds, all of which in a greater or less degree subsist on insects. For this purpose the bill is always more or less toothed near the tip, which is frequently strongly hooked. The shrikes, thrushes, and robins, are familiar examples of the birds of this group.

Fam. 1. Sylviadæ, or Warblers. Bill subulate, generally slender, tip of upper mandible emarginated ; wings more or less lengthened, generally rounded, sometimes pointed ; tail various, frequently rounded. Tarsi long, slender ; toes mostly long, claws curved and acute. Size small.

This extensive family is composed of a large number of birds, many of which are noted for their powers of song. They are found in all parts of the world.

Sub-fam. 1. *Malurinæ, or soft-tailed Warblers.* Bill moderate, generally slender and straight, tip of upper mandible curved ; wings short, rounded ; tail more or less lengthened and rounded ; tarsi generally long and slender ; toes long, claws strong, acute.

About one hundred and twenty species of birds are classed here, which are restricted to the old world and Australia. They have derived the name of soft-tailed warblers from having generally fan-like tails, the feathers of which frequently have webs of remarkable softness to the touch. Many of the species have very loud notes, sometimes agreeable, but frequently unpleasant.

Australia produces about a dozen little birds of this sub-family which are very beautiful. The superb warbler (*Malurus superbus*) is one of the most common, and is clothed in plumage of splendid sky blue and black, presenting a singular contrast of colors. Others of this genus are equally handsome, though the species of this sub-family are generally of plain plumage.

Sub-fam. 2. *Sylvianæ, or true Warblers.* Bill rather long, slender, nearly straight, compressed, curved at the tip ; wings moderate, rounded ; tail rather long, rounded ; tarsi lengthened, slender ; toes long, slender ; claws long, curved, and sharp. Size small.

This sub-family comprises about one hundred birds, including the warblers of Europe, the nightingales, golden crested wrens, and some other genera of birds not so well known, species of which inhabit the entire surface of the globe. The former, composing the old genus Sylvia, are common European birds. The nightingales, of which there are two species, have been celebrated for their transcendent powers of song from the earliest period of recorded history.

The smaller species (*Philomela luscinia, pl.* 103, *fig.* 13) is the best singer, and is the bird usually alluded to as *the* nightingale. It is a small

bird of very plain plumage, light brownish grey above and white on the lower parts of the body, native of the whole of Europe as far north as Sweden, all Asia as far as Siberia, and northern Africa, everywhere choosing its residence in shady woods, thickets, or even hedges in the fields. It is also partial to thickly set orchards and gardens, and is supposed to have a great preference for the neighborhood of its birth.

The nightingale is migratory, and appears in northern Europe about the middle of April; and it is during the season of selecting his mate and attending to the duties of rearing his young, that the male pours out that incomparable song which has established him as the greatest of feathered vocalists, beyond comparison.

"The nightingale," says Dr. Bechstein (Nat. Hist. of Cage Birds), "expresses his different emotions by suitable and particular tones. The most unmeaning cry when he is alone appears to be a simple whistle, '*fitt;*' but if the syllable '*err*' is added, it is then the call of the male to the female. The sign of displeasure or fear is '*fitt,*' repeated rapidly and loudly before adding the terminating '*err;*' whilst that of satisfaction and pleasure, such for example as conjugal endearments, or on the occasion of finding a delicate morsel, is a deep '*tack,*' which may be imitated by smacking the tongue.

"In anger, jealousy, rivalry, or any extraordinary event, he utters hoarse and disagreeable sounds somewhat like a jay or a cat. Lastly, in the season of pairing, when the male and female entice and pursue each other from the top of a tree to its base, and thence again to the top, a gentle subdued warbling is all that is heard.

"Nature has granted these tones to both sexes; but the male is particularly endowed with such very striking musical talents, that in this respect he surpasses all birds, and has acquired the name of the king of songsters. The strength of his vocal organ is indeed wonderful, and it has been found that the muscles of his larynx are much more powerful than those of any other bird. But it is less the strength than the compass, flexibility, prodigious variety, and harmony of his voice which make it so admired by all lovers of the beautiful. Sometimes dwelling for minutes on a strain composed of only two or three melancholy tones, he begins in an under voice, and swelling it gradually by the most superb *crescendos* to the highest point of strength, he ends it by a dying cadence; or it consists of a rapid succession of more brilliant sounds, terminated, like many other strains of his song, by some detached ascending notes. Twenty-four different strains or couplets may be reckoned in the song of a fine nightingale, without including its delicate variations; for among these, as among other musicians, there are some great performers and many middling ones.

"It is true that the nightingales of all countries, the south as well as the north, appear to sing in the same manner; there is, however, as has been already observed, so great a difference in the degree of perfection that we cannot help acknowledging that one has a great superiority over another. On points of beauty, however, when the senses are the judges, each has his peculiar taste. If one nightingale has the talent of dwelling agreeably on

his notes, another utters his with peculiar brilliancy, a third lengthens his strain in a peculiar manner, and a fourth excels in the *silveriness* of his voice. All four may excel in their style, and each will find his admirer; and truly it is very difficult to decide which merits the palm of victory."

The larger species of nightingale (*Philomela major*) is abundant in some parts of the continent of Europe, especially Austria, Hungary, and Poland. It is said to sing more generally at night than the former, but does not appear to approach it in general vocal ability. It pronounces notes similar to the names David and Jacob with great distinctness, and with the latter it generally begins its song.

The black cap warbler, *Curruca atricapilla* (*pl.* 103, *fig.* 15), is abundant throughout Europe as far north as Sweden. The garden warbler, *C. hortensis* (*pl.* 103, *fig.* 14), is not so common, and is of more retired habits. The willow wren, *Sylvia hippolais* (*pl.* 100, *fig.* 7), is another European species.

This sub-family includes also the redstarts of Europe (*Phœnicura*), the most abundant species of which is the common redstart, *P. ruticilla* (*pl.* 103, *fig.* 16). It is a very pretty little bird, with the tail entirely of a deep orange-red color, and inhabits the whole of Europe and probably Asia. Another species is the blue-throated or Swedish redstart, *P. suecica* (*pl.* 102, *fig.* 12), one of the prettiest of European birds.

The crested wrens also belong here (*Regulus*), of which there are numerous species. They are amongst the smallest of birds, and are remarkable for their active habits, and the hardihood with which they brave the northern winters. They are restricted to North America, Northern Europe, and Asia; the golden-crested wren, *R. auricapillus* (*pl.* 103, *fig.* 12), is the most numerous species of Europe.

Sub-fam. 3. *Erythacinæ, or Robins of the Old World.* Bill moderate, more or less slender, rather depressed at base, compressed towards the tip; wings generally rather short and rounded, sometimes long; tail usually short and broad, generally even and rather rounded at the end. Tarsi long, slender; toes moderate, claws curved and acute. Size small.

This sub-family contains the robins, stonechats, and several other genera of the old world, and the familiar blue-birds of America; in all about one hundred species.

The stonechats and wheatears of Europe are classed in the genus *Saxicola.* They are birds common throughout the continent. The wheatear, *S. œnanthe* (*pl.* 103, *fig.* 18), in Great Britain lives in the moors and open fields, where it makes its nest under large stones or in the crevices of walls. It is a bird of handsome form, but very shy and timid; though vast numbers are caught in traps for the table, being esteemed a great delicacy.

The robin or redbreast of Europe is a famous and long established favorite. It is a small bird, not larger than the blue-bird, to which it bears considerable resemblance in habits and general history. *Erythaca rubecula* (*pl.* 102, *fig.* 13).

"The common robin," says Sir William Jardine, "has been frequently described, and has been the subject of many anecdotes from the time of the

publication of the 'Babes in the Wood' to the present day. A marked peculiarity in the manners of this bird is its familiarity. A constant attendant on the works of man, it follows him during his out of door avocations, and enters his dwellings, as if conscious of the general feeling with which it is beheld, and unsuspicious of the possibility of being entrapped by the closing of the doors or windows. This may be accounted for both by a disposition to sociality with mankind and cultivation, undoubtedly innate to many tribes of creatures, and particularly to the *Ruminantia* and *Rasores*, which this bird in its own circle will partly represent; and it may also be attracted by the prospect of food, which instinct teaches will be found in its vicinity. When the weather becomes severe many are drawn towards our houses, entering for warmth and to collect food. At first they are wary and watchful, but if unmolested and allowed a free egress, they will take up their abode in a room or a lobby for a month at a time, selecting a roosting-place on the cornice or on some curtain top, warbling their song when the day is clear or the fire burns brightly, and in every way seeming at ease and in confidence with the inmates."

The robin is distributed over the whole of Europe and the adjoining parts of Asia and Africa.

The pretty and familiar blue-bird (*Sialia wilsoni*) of the United States belongs here.

"The pleasing manners and sociable disposition," says Wilson, "of this little bird entitle him to particular notice. As one of the first messengers of spring, bringing the charming tidings to our very doors, he bears his own recommendation always along with him, and meets with a hearty welcome from everybody.

"Though generally accounted a bird of passage, yet so early as the middle of February (in Pennsylvania), if the weather be open, he usually makes his appearance about the old haunts, the barn, orchard, and fence posts. Storms and deep snows sometimes succeeding, he disappears for a time; but about the middle of March is again seen accompanied by his mate, visiting the box in the garden, or the hole in the old apple tree, the cradle of some generations of his ancestors. The preliminaries being settled and the spot fixed on, they begin to clean out the old nest and the rubbish of the former year, and to prepare for their future offspring. Soon after this another sociable little pilgrim, the house wren, also arrives from the south; and finding such a snug berth pre-occupied shows his spite by watching a convenient opportunity, and in the absence of the owner popping in and pulling out sticks, but takes special care to make off as fast as possible.

"The usual spring and summer song of the blue-bird is a soft, agreeable, and oft-repeated warble, uttered with open, quivering wings, and is extremely pleasing.

"In his motions and general character he has great resemblance to the *robin redbreast* of Britain, and had he the brown olive of that bird, instead of his own blue, could scarcely be distinguished from him. Like him he is

known to almost every child, and shows as much confidence in man by associating with him in summer, as the other by his familiarity in winter. He is also of a mild and peaceful disposition, seldom fighting or quarrelling with other birds.

"Towards fall, that is in the month of October, his song changes to a single plaintive note as he passes over the yellow many-colored woods, and its melancholy air recalls to our minds the approaching decay of the face of nature. Even after the trees are stripped of their leaves, he still lingers over his native fields as if loth to leave them.

"Indeed he appears scarcely ever totally to forsake us, but to follow fair weather through all its journeyings till the return of spring."

There are two other species of blue birds, one of which is found in California and other countries of Western America, and the other in the countries of North-western America. They both bear a general resemblance to Sialia wilsoni.

About one hundred birds belong to this sub-family, which inhabit all parts of the world, and are generally pretty and cheerful little birds, more or less similar to the American blue-bird and the European robin.

Sub-fam. 4. *Accentorinæ, or Hedge Warblers.* Bill short, straight, sometimes conical, sides compressed towards the tip; wings more or less long, pointed, sometimes rounded; tail moderate; tarsi and feet rather long, claws strong.

The most familiar of these birds are the hedge sparrow (*Accentor modularis*) and the Alpine warbler (*A. alpinus*), both common European birds.

Other birds of this sub-family are found in all parts of the world, but are most numerous in Australia. The species of this continent constitute the genus *Acanthiza*, and are represented as usually observed in the lower branches of trees, in the bushes, and on the ground, and possessing generally the characters and general history of insect-eating birds.

Sub-fam. 5. *Parinæ, or Tits.* Bills rather short, strong, sometimes conical and straight; wings moderate or short; tail generally long, rounded; tarsi and feet rather long. Size small.

A sub-family of birds universally known as tits or titmice, and found all over the world.

The most common American species is the crested tit (*Parus bicolor*), which is a constant resident in all parts of the United States, and distinguished for the promptness with which he pipes out his few but musical notes on the very first days of fine weather in spring. Notwithstanding his plain plumage he is an exceedingly graceful and in fact elegant little bird, and very quick and rather eccentric in his actions.

Several other species of crested tits have been discovered within the limits of the United States. The plain tit (*P. inornatus*) was discovered by Dr. Gambel in the Rocky Mountains; two others, the black-crested tit (*P. atricristatus*) and the Texan tit (*P. annexus*), were discovered by Mr. John Audubon (son of the celebrated ornithologist) in Texas.

The black-capped tits (not crested) seem to form a distinct genus. The

two most common in the United States are the common tit and the Carolina tit (*P. atricapillus* and *carolinensis*).

There are several European species, of which the common titmouse, *Parus major* (*pl.* 102, *fig.* 4), and the European crested tit, *P. cristatus* (*pl.* 102, *fig.* 3), are well known.

About fifty species of these pleasant little birds are distributed over the various countries of the globe, and are generally very similar in habits to those more particularly enumerated.

Sub-fam. 6. *Sylvicolinæ, or American Warblers.* Bill straight, more or less conical, sides compressed; nostrils basal, with the opening rather large and exposed; wings rather long, generally pointed; tail moderate; tarsi and feet rather long and stout. Size small; colors generally gay and agreeable.

This sub-family embraces all the American warblers, of which there are about one hundred species described, and several genera of similar birds which are natives of India and Africa.

The species of the United States are amongst the most beautiful and lively of our birds, though, on account of their living almost exclusively in the woods, they are little observed. A few species reside exclusively in the South, but the greater number breed in all the Northern States and British territories adjacent.

One of the most common species is the summer yellow-bird (*Sylvicola æstiva*), a beautiful little bird with bright yellow plumage, striped on the breast and belly with a deeper orange yellow. It is a very lively and by no means shy little bird, often seen in the garden or among the blossoms of trees in the spring, and makes its nests in bushes or shrubbery.

The magnolia warbler (*S. maculosa*) is a beautiful species, though never venturing far from the woods. It is black above and bright yellow below, with black stripes. It breeds in the far north, migrating only through the middle states in the spring and autumn.

The yellow-crowned warbler, or yellow rump, as it is mostly called (*S. coronata*), is a very common species in the spring. It is dark-colored above and white below, with a bright golden yellow crown, and with the rump yellow.

The golden-winged warbler (*S. chrysoptera*), the black-throated green warbler (*S. virens*), the blackburnian (*S. blackburniæ*), the yellow-throated (*S. pensilis*), the bay-breasted (*S. castanea*), the chestnut-sided (*S. icterocephala*), the Maryland yellow-throat (*S. marylandica*), and some others, are more or less frequently met with every spring; sometimes very common, at other times very rare.

The Connecticut warbler (*S. agilis*), the Cape May warbler (*S. maritima*), and the mourning warbler (*S. philadelphia*), have hitherto appeared but rarely in any part of the United States or elsewhere.

The genus *Zosterops* comprises about twenty birds of India and Africa. They appear to bear considerable resemblance to our warblers, being mostly observed in the trees or bushes actively engaged in searching for insects, which constitute their only food.

Sub-fam. 7. *Motacillinæ, or Wagtails.* Bill rather long, slender, and straight, sides much compressed; nostrils lateral; wings long, pointed; tail generally long; tarsi long, slender; feet rather strong. Size small.

About seventy-five birds are classed here. They inhabit all parts of the world, and habitually frequent the ground, and very often are partial to the vicinity of streams of water.

One of the best known species is the grey wagtail of Europe, *M. boarula* (*pl.* 103, *fig.* 17). It inhabits all Europe and contiguous parts of Asia and Africa, but does not appear to be very common. It lives in the vicinity of streams, and frequently nestles in the immediate neighborhood of mills or other buildings.

The birds of this sub-family all bear more or less resemblance to the wagtails of Europe.

Fam. 2. Turdidæ, or Thrushes. Bill various, but always more or less strong and curved, generally compressed; wings generally more or less long, frequently pointed, sometimes rounded; tail generally moderate; tarsi and feet generally strong. Size moderate, but larger than the last family.

The thrushes constitute a very extensive and completely cosmopolitan family of birds, generally distinguished by considerable powers of song, and frequently familiar and sociable in their habits.

There are not less than six hundred species of thrushes.

Sub-fam. 1. *Formicarinæ, or Ant-thrushes.* Bill long, straight, curved at the tip, which is frequently hooked; wings generally short, rounded; tail short; tarsi long; toes generally long and stout. Size moderate.

A sub-family, nearly all the species of which subsist upon insects captured upon the ground. They are almost invariably long-legged and short-tailed birds, with long stout bills, and are frequently of gay plumage, though of odd, and, in fact, rather droll general appearance.

The ant-thrushes are natives of all parts of the world, though most numerous in India and South America. The species which inhabit the former and some other countries and islands of Asia, form the genus *Pitta* of naturalists, and are for the most part very beautiful. They live almost entirely upon the ground, and, if disturbed, like almost all other birds of this group, seek safety in running rather than by flight. The short-tailed Indian ant-thrush (*P. brachyura*) and the blue-tailed ant-thrush (*P. cyanura*) are frequently met with.

The American ant-thrushes are numerous, and, though inferior in size and beauty of plumage to their Indian relatives, are represented as precisely the same in general characters and habits. About seventy-five species inhabit tropical America, some of the best known of which are the Cayenne ant-thrush (*Formicaria colma*), the king ant-thrush (*Grallaria rex*), the rufous crowned (*G. ruficapilla*), and others.

Sub-fam. 2. *Turdinæ, or true Thrushes.* Bill long, generally strong, and more or less curved and compressed; wings moderate; tail long, broad, and generally graduated; tarsi and feet moderately long and strong.

Contains all the birds commonly known in Europe and America as thrushes, of which there are about one hundred and fifty species. They

are found in all parts of the world, and are conspicuous for variety and sweetness of song. The European species are represented as birds of rather shy disposition, most usually frequenting the skirts of the forests, and the thickets and bushes of extensive pastures, while some prefer the wilds of mountains or deserts. They are all in a greater or less degree migratory, residing in the south during the winter.

The fieldfare, *Merula pilaris*, the missel thrush, *M. viscivorus* (*pl.* 100, *fig.* 12), the song thrush, *M. musica* (*pl.* 100, *fig.* 14), the European blackbird, *M. vulgaris* (*pl.* 100, *fig.* 9), the ring ouzel, *M. torquata*, the redwing, *M. iliaca* (*pl.* 100, *fig.* 13), and the rock thrush, *M. saxatilis* (*pl.* 100, *fig.* 10), are the more common European species.

The common migratory thrush or American robin, *Merula migratoria*, belongs here. It is found in all parts of North America, and in the United States is known to everybody. It is migratory, but may almost be considered resident in all parts of the United States south of Baltimore. It lives almost entirely in the orchards and cultivated grounds of farmers, making its nest generally in a tree of the former, substantially plastering it inside with mud.

In autumn, robins are favorite game with our juvenile and other amateur sporting population, with whom they have the reputation of being good at sitting still to be shot at. Vast numbers are destroyed every autumn, especially in the vicinity of cities.

In this division is classed also the family of American mocking birds, of which there are about twelve or fourteen species.

The mocking bird of the United States, *Mimus polyglottus*, is our most famous singer, which high position his accomplishments fully entitle him to.

"His own native notes," as Wilson observes, "are easily distinguishable by such as are well acquainted with those of our various song birds. They consist of short expressions of two, three, or at most of five or six syllables, generally interspersed with imitations, and all of them uttered with great emphasis and rapidity. He many times deceives the sportsman, and sends him in search of birds that perhaps are not within miles of him, but whose notes he exactly imitates; even birds themselves are frequently imposed on by this admirable mimic, and are decoyed by the fancied calls of their mates, or dive with precipitation into the depth of the thicket, at the scream of what they suppose to be the sparrow-hawk.

"This excessive fondness for variety, however, in the opinion of some, injures his song. His elevated imitations of the brown thrush are frequently interrupted by the crowing of cocks; and the warblings of the bluebird, which he exquisitely manages, are mingled with the screaming of swallows or the cackling of hens; amidst the simple melody of the robin, we are suddenly surprised by the shrill reiterations of the whip-poor-will; while the notes of the killdeer, blue jay, martin, Baltimore oriole, and twenty others, succeed with such imposing reality, that we look round for the originals, and discover with astonishment that the sole performer in this singular concert is the admirable bird now before us."

The mocking bird is found throughout the United States.

The other species of mocking birds inhabit South America, but are not represented as possessing vocal powers at all comparable to the species of the north.

The rufous thrush or thrasher, *Mimus rufus*, is classed here. He is usually rated as the next best songster of all birds, appearing in Pennsylvania about the first of May, and thence extending northwards to Canada.

The cat bird, *M. carolinensis*, is also a member of this extensive group of birds. No bird is better known in the United States, and, notwithstanding his usually unpleasant notes, he can, upon sufficient inducement, raise a very respectable song.

Sub-fam. 3. *Timalinæ, or Babblers.* Bill moderate, rather long, compressed; wings short, rounded; tail generally rather long and graduated; tarsi long, robust; toes long, strong; claws long, acute. Size moderate.

A remarkable group of long-tailed thrush-like birds inhabiting all parts of the world except Europe, and remarkable for their fantastic movements and singular voices. The note uttered by one of these birds is compared by a distinguished naturalist (Mr. Jerdon), who long resided in India, to a sort of cracked Punch-and-Judy laugh, which is no sooner begun by one, than the others of the flock follow in chorus.

The Indian babblers (genus *Timalia*) are abundant in the cultivated grounds around the villages of India, generally frequenting the ground in search of insects and seeds. They utter continually a low chattering noise, which is occasionally changed to a loud guttural cry, though some of the species are capable of singing quite agreeably.

The only representative of this sub-family in the United States is the yellow-breasted chat, *Icteria viridis*, which is rather frequently *heard* in marshy and bushy places, but, being very shy, is less frequently *seen*. It is a very handsome bird, olive green above, and fine yellow on the lower parts of its body. Like the other birds of this sub-family, it is remarkable for its curious voice. "First is heard," says Wilson, "a repetition of short notes resembling the whistling of the wings of a duck or teal, beginning loud and rapid, and falling lower and slower till they end in detached notes; then a succession of others, something like the barking of young puppies, followed by a variety of hollow guttural sounds, each eight or ten times repeated, more like those proceeding from the throat of a quadruped than that of a bird, which are succeeded by others not unlike the mewing of a cat, but considerably hoarser."

This bird inhabits the whole of the United States; another species, very similar, has been discovered in California.

Sub-fam. 4. *Oriolinæ, or Orioles.* Bill rather long, broad at base, stout, and compressed; wings long, rather rounded; tail moderate, rather wide; tarsi and feet short and strong. Colors mostly yellow.

These birds are confined to the old world, being most abundant in India. One species, *O. galbula* (*pl.* 100, *fig.* 8), occasionally visits Europe. It is a very handsome bird, of pure lemon yellow plumage, somewhat resembling the Baltimore oriole, though much larger. The birds of the present sub-family must not, however, be confounded with the American orioles, which

do not belong here. The black-headed oriole, *O. melanocephalus*, is one of the most common Indian species. Its plumage is fine yellow, with the head black.

One of the most beautiful of this group is the golden-headed oriole, *Sericulus chrysocephalus*, of Australia. Its plumage is of the most splendid golden yellow and black. It is frequently met with in collections of birds, and sold by dealers as a species of paradise bird. It appears to be a common bird in Australia.

Sub-fam. 5. *Pycnonotinæ, or Bulbuls.* Bill short, curved, compressed; wings moderate, rather short, rounded; tail long, broad, rather rounded; tarsi long; feet moderate, rather short and weak. Size small; head frequently crested.

A small group, composed of about seventy-five species of birds, which exclusively inhabit Asia and Africa. They appear to have the general characters of the other groups of thrushes, live mostly in small parties, and feed indiscriminately upon fruits and insects. The Asiatic species are frequently remarkable for eminent vocal powers; and one of them, *Pycnonotus jocosus*, is the Eastern nightingale, or bulbul, of oriental poets. It is a bird scarcely as large as the cat bird of the United States, of plain brown on the back, and white below, with a black head and crest. Its song is said to be very melodious.

There are a number of birds belonging to this sub-family, and nearly related to the bulbuls, which are found in Africa.

Fam. 3. Muscicapidæ, or Flycatchers. Bill of various lengths, generally broad and depressed at the base, with the sides compressed at the tip; gape usually furnished with long and strong bristles; wings and tail generally long; tarsi and feet generally short and weak. Size various, never very large, frequently quite small.

A large family of birds, generally of small size and plain plumage, which are found in every country of the world. They most abound, however, within the tropics.

There are about five hundred and fifty species of flycatchers.

Sub-fam. 1. *Querulinæ, or Mourning Flycatchers.* Bill rather long, depressed, broad at base; gape furnished with strong bristles; wings more or less lengthened; tail long and broad; tarsi and feet short and strong. Size rather large.

Containing only eight or ten birds, found in South America. They inhabit the forests, and are mostly observed in small parties. feeding on insects or fruits in the loftiest trees, and are said to have very plaintive notes.

The red-necked flycatcher, *Querula rubricollis*, is the best known species. Its plumage is fine black, with a scarlet throat. The military flycatcher, *Q. militaris*, is another very showy species, though more rare. Its plumage is of fine scarlet.

Sub-fam. 2. *Alectrurinæ, or Walking Flycatchers.* Bill more or less lengthened, broad at base, and rather depressed; wings more or less long; tail generally lengthened; tarsi long and slender. Size small.

About twenty-five birds are arranged here, which are restricted to the warm regions of South America. They generally live in low bushes, among the lower branches of trees, or on the ground, and their food is said to consist principally of coleopterous insects (beetles, &c.).

Fluvicola cursoria is a common species.

Sub-fam. 3. *Tyranninæ, or Tyrant Flycatchers.* Bill more or less long, broad, and depressed at base, sides compressed to the tip, which is hooked; wings generally lengthened and pointed; tail moderate, generally broad; tarsi and feet short and generally weak. Size mostly small.

Another exclusively American group, containing a large number of birds, king birds, pewees, tyrants, &c., of which the greater part are found only in South America.

There are several North American species, however, of which the common king bird of the United States, *Tyrannus intrepidus*, is a good example.

He is abundant from Florida to Canada, and is quite sociable and familiar in his habits and disposition, almost invariably building his nest in the immediate vicinity of dwelling-houses. He is very pugnacious, and makes a very respectable show of fight with almost any other bird that dares to intrude upon his privileges, although it may be much larger and stronger than himself.

The king bird has no song, and but little voice of any kind.

The great crested flycatcher, *T. crinitus*, is another species, though much less frequently seen than the king bird.

The greater part, however, of the North American flycatchers belong to the genus *Tyrannula*, or little tyrants, of which the species are numerous in both North and South America.

One of the best known species is the common pewee, or pewit, *T. nunciola*, which is a universal favorite with our population.

Though possessing very limited vocal abilities, the notes of this little bird are pleasing, because they are almost the first heard at the return of spring, and he forthwith begins the construction of his nest, about the barn, in a shed, or some such place, little annoyed by the family of his landlord or by domestic animals.

This common and favorite bird spends the winter in the south. "I have found," says Audubon, "this species abundant in Florida in winter, in full song, and as lively as ever; also in Louisiana and the Carolinas, particularly in the cotton fields. They leave Louisiana in February and return in October."

The wood pewee, *T. virens*, is very common in the woods

Several other species are found in North America, such as Say's flycatcher, *T. saya*, Cooper's flycatcher, *T. cooperii*, the green crested, *T. acadica*, the yellow-bellied, *T. flaviventris*, and some others.

A large number of species, composing several genera, inhabit South America, such as *Milvulus forficatus* (*pl.* 103, *fig.* 10) and *Tyrannus severus* (*pl.* 103, *fig.* 9).

Sub-fam. 4. *Tityrinæ, or Becards.* Bill rather short, broad at base,

depressed; wings long, pointed; tail short, rounded; tarsi and feet short and strong. Size moderate; colors plain.

About fifty species of peculiar-looking birds constitute this sub-family. They are strictly confined to South America and the West Indies, migrating according to the seasons, and living exclusively on insects.

The Cayenne flycatcher, *Tityra cayanus*, is a well known species. Its plumage is almost entirely dusky white, with a black head.

Sub-fam. 5. Muscicapinæ, or true Flycatchers. Bill moderate, broad at base, gradually compressed to the tip; gape furnished with strong bristles; wings long and generally pointed; tarsi and feet short and slender. Size generally small.

An extensive sub-family, containing not less than two hundred and fifty species of birds, inhabiting all parts of the world.

The North American species belong to the genus *Setophaga*, one of the most common species of which is the American redstart, *S. ruticilla*. It is abundant in the woods during summer, and is a very lively and pretty little bird.

"This," says Audubon, "is one of the most lively as well as one of the handsomest of our flycatchers, and ornaments our woods during spring and summer, when it cannot fail to attract the attention of any person who may visit the interior of the shady forests. It is to be met with over the whole of the United States, where it arrives, according to the different localities, between the first of March and the first of May. It takes its departure, on its way southward, late in September and in the beginning of October."

The hooded flycatcher, *S. mitrata*, is a very handsome species belonging to this sub-family. Its plumage is of bright yellow and green, with a black hood covering the greater part of the head.

The Canada flycatcher, *S. canadensis*, is another beautiful little bird, which is frequently met with in all parts of the United States.

The most abundant European species are the grey flycatcher, *Muscicapa grisola* (*pl.* 101, *fig.* 17), and the white-necked flycatcher, *M. albicollis* (*fig.* 18).

Nearly all the many remaining species of these birds are natives of the tropical regions of Asia, Africa, and America.

A very beautiful species of South America is the great-crested, or king of the flycatchers, *M. regia* (*pl.* 101, *fig.* 19), remarkable for its large crest of purple and crimson feathers. It is frequently brought in collections.

Sub-fam. 6. Vireoninæ, or Greenlets. Bill moderate, straight, compressed, tip curved; gape with short bristles; wings rather long; tail moderate; tarsi and feet rather long, and moderately strong. Size small; colors generally olive green and white.

About a dozen birds of peculiar form and habits are arranged here. They are almost exclusively North American, two or three species only having been found in the southern parts of this continent.

The red-eye, *Vireo olivaceus*, the warbling flycatcher, *V. gilvus*, the solitary, *V. solitarius*, the white-eye, *V. noveboracensis*, and the yellow-breasted, *V. flavifrons*, are the commonest species.

The first (the red-eye) is one of the most abundant birds in the woods of the northern states. In the spring months, he is one of the most conspicuous of our singers, and, though his notes are short, they are very musical and lively. He builds a very pretty hanging nest, frequently on a low bush, in which he raises two broods in the season.

The white-eyed flycatcher is remarkable for his exceedingly loud voice, and great disposition to use it upon all occasions. He frequents bushes and places overgrown with briers, especially the green brier (*Smilax*), where he makes himself heard at all hours of the day.

The other species mentioned above are less frequently met with.

Fam. 4. Ampelidæ, or Chatterers. Bill moderately strong, generally broad at base, and depressed, compressed to the tip; wings long; tail moderate; tarsi and feet usually short.

This family, though not so numerous in species as the preceding, is distributed throughout the world; most abundant, however, in tropical regions.

The species are for the greater part showy birds, but many of the smallest species especially are remarkable for the richness of their colors.

Sub-fam. 1. *Pachycephalinæ, or Broad-headed Chatterers.* Bill moderate, broad at base, compressed to the tip, gape with a few slender bristles; wings moderate, more or less rounded; tarsi and feet rather lengthened and slender.

A group of about fifty little birds peculiar to India and Australia. The Australian species are most numerous, and are pretty little birds found in localities of very various characters, sometimes in the forest and occasionally in the vicinity of dwellings. *Pardalotus puctatus* is one of the common species.

Sub-fam. 2. *Piprinæ, or Manakins.* Bill short, broad at base, depressed, rather arched, compressed to the tip; wings short; tail short, truncate; tarsi and feet rather long and slender. Size small, plumage frequently handsome. Found in South America, except one species which inhabits India. They are represented as being very lively and active in their habits, and are said to have very discordant voices, the note of one species having been compared by a traveller to the sound produced by cracking a nut.

The long-tailed manakin (*Pipra caudata*), the black-headed (*P. melanocephala*), the blue manakin (*P. pareola*), and the red-headed (*P. erythrocephala*), are common species.

The cock of the rock, *Rupicola aurantia* (*pl.* 101, *fig.* 16), is arranged here. It is a beautiful bird, entirely clothed in bright orange-red plumage, with a crest laterally compressed, giving it a very peculiar appearance. It inhabits the warmer parts of South America, and frequents the vicinity of retired, rocky places, in the interior of the forests.

The green cock of the rock (*Calyptomina viridis*) is the Indian species which is placed in this group. It is found in the forests, and appears to be quite similar in habits to the South American bird.

Sub-fam. 3. *Ampelinæ, or True Chatterers.* Bill rather long, very

wide at base, depressed; wings moderate; tail generally short and truncate; tarsi short, toes long. Colors gay; size various.

The majority of these birds inhabit South America, and are remarkable for the richness of the colors of their plumage. They feed on fruits and insects, and migrate according to the season. The blue chatterer (*Ampelis cærulea*), the banded chatterer, *A. cortinga* (*pl.* 101, *fig.* 21), and the purple chatterer (*A. pompadora*), are frequently met with, as is also a beautiful scarlet-crested species, *A. carnifix* (*fig.* 20).

The Bohemian chatterer of Europe (*Bombycilla garrula*), and the cedar bird of America (*B. cedrorum*), belong to this sub-family. The former species is found in the forests of Northern Europe and also in the northern parts of America. The latter, which is the cedar bird of the United States, frequents cedar woods and such localities throughout this country. This and the other species of the same genus have very fine silky plumage of deep ashy color, and are remarkable for the curious appendages to the tips of their wing feathers, which have much the appearance of small drops of red sealing-wax.

Sub-fam. 4. *Campephaginæ, or Caterpillar-catchers.* Bill short, depressed, gape furnished with short bristles; wings moderate; tail rather long; tarsi and feet short.

About sixty birds compose this group, which are distributed over the tropical regions of the old and new worlds. Many of the Indian species are very showy birds, with bright scarlet plumage, living in the recesses of the forests, and disposed to hide themselves when approached. At least thirty of the species are restricted to the Indian islands and to Australia. Others have plain grey or ashy plumage, such as *Campephaga nigra* and *melanops*, which are frequently seen in collections.

Sub-fam. 5. *Dicrurinæ, or Drongo Shrikes.* Bill rather lengthened, broad at base, curved, gape with strong bristles; wings long; tarsi and feet short and strong; tail frequently long and forked. Size larger than the preceding. Colors frequently black.

This sub-family is composed of about forty birds, strictly confined to Asia and Africa.

The location of this sub-family here is of very doubtful accuracy, as the affinities of the birds composing it are evidently more to the family immediately succeeding.

A genus (*Artamus*) composed of ten or twelve species is arranged here. They are called swallow shrikes on account of their having long, swallow-like wings. They principally inhabit India, and are commonly observed in pursuit of insects on the wing.

The drongo shrikes (*Dicrurus*) are mostly rather large birds of perfectly black plumage, with the tail long and deeply forked. They exclusively inhabit India and Africa. The Malabar shrike (*D. malabaricus*), and the forked-tailed drongo, *D. forficatus* (*pl.* 102, *fig.* 15), are frequent species.

The hooked-bill shrike, *Vauga curvirostris* (*pl.* 102, *fig.* 17), belongs here.

FAM. 5. LANIIDÆ, OR SHRIKES. Bill rather long, very strong and

straight, generally toothed and hooked, gape generally with bristles; wings generally moderate; tail more or less lengthened; tarsi and feet strong; claws curved and sharp.

A family consisting of about one hundred and fifty birds, which represent the strongest rapacious characters of the Dentirostres. No others have the bill so strongly toothed as those of the genus *Lanius*, which fact induced Linnæus to arrange them as rapacious birds.

These birds are distributed throughout the world.

Sub-fam. 1. *Laniinæ, Butcher Birds, or Shrikes.* Bill strong, rather short, curved, much compressed, hooked, and generally strongly toothed: wings generally long and rounded; tail moderate; tarsi and feet rather short and robust; claws curved and acute.

This sub-family is distributed over the whole surface of the globe. All the species are of remarkably predaceous habits, preying upon insects, reptiles, and even other birds, which, it is said, they destroy by strangling. Some of the species impale insects on thorns for the purpose of securing them while feeding. The butcher bird of Europe, *Lanius exubitor* (*pl.* 102, *fig.* 20), is well known, being a very common bird in France, and generally distributed throughout the continent. The red-backed shrike, *L. collurio* (*pl.* 102, *fig.* 19), is another European species of frequent occurrence.

The North American species best known are the northern butcher bird (*L. septentrionalis*) and the Louisiana butcher bird (*L. ludovicianus*). The former inhabits the whole territory of the United States, and is almost as rapacious as the small hawks. He is rather a handsome bird, with fine grey and white plumage, and is known in some districts by the name of the winter mocking-bird, having some resemblance to the bird indicated. The Louisiana species is similar in general appearance and habits, and is almost restricted to the Southern States.

Several other species are natives of Asia and South America.

Sub-fam. 2. *Thamnophilinæ, or Bush Shrikes.* Bill lengthened, straight, compressed, hooked at the tip, gape more or less bristled; wings moderate, rounded; tail long, rounded; tarsi and feet moderate. Size various.

Africa and South America are the countries inhabited by the bush shrikes, though one genus found in New Guinea is arranged here.

The South American species inhabit the vast forests of that portion of this continent, and are said to live almost exclusively on beetles and other hard-shelled insects. The striped shrike (*Thamnophilus doliatus*) and the spotted shrike (*T. nævius*) are common species.

The African birds of this sub-family (genus *Laniarius*) generally have considerable beauty of plumage, the prevailing colors being fine black and scarlet; the Barbary shrike, *L. barbarus* (*pl.* 102, *fig.* 18), and the olive-colored shrike (*L. olivaceus*), are frequently met with. The species from New Guinea belong to the genus *Cracticus;* they are similar in general habits and history to the others of this sub-family. One of the most common species is the black and white shrike, *C. varius* (*pl.* 102 *fig.* 16).

SUB-ORDER 4. CONIROSTRES, OR CONE-BILLED BIRDS.

Another very large assemblage of birds, comprising the crows, starlings, sparrows, finches, grosbeaks, tanagers, and many other birds distributed throughout the world. They have the bill always strong, and more or less conical, and are in all respects fitted for subsisting on fruits or seeds, which are the exclusive food of many groups, though others are omnivorous, and eat indiscriminately vegetable or animal substances; the latter, however, more by necessity than choice.

FAM. 1. CORVIDÆ, OR CROWS. Bill rather lengthened and strong, somewhat curved, and frequently with bristle-like plumes at its base. Wings generally long and pointed; tail rather long; tarsi and feet strong.

This family comprises all the birds known as crows, jays, magpies, and several other groups of birds more or less nearly related to them.

Sub-fam. 1. *Phonygaminæ, or Piping Crows.* Bill lengthened, broad at base, extended upon the forehead; wings long, pointed; tail rather long; tarsi and feet strong. Size rather large.

About ten species only of very peculiar birds are arranged in this group. They are found only in Australia and the Island of New Guinea. The Australian species have rather handsome plumage of white and black colors, and although they appear to possess habits bearing a general resemblance to those of the crows, some of the species have voices which are rather agreeable; others, however, have such clamorous and discordant notes that they have acquired the generic name of Strepera. *S. graculina* is a common species.

Sub-fam. 2. *Garrulinæ, or Jays.* Bill moderate, rather strong, compressed, curved; wings moderate, rounded; tail various, usually lengthened and rounded; tarsi and feet moderate; toes long. Size smallest of this family, colors more or less blue and white.

This sub-family contains the jays of Europe and Asia, and of America, of which there are about forty species.

The common jay of Europe, *Garrulus glandarius* (*pl.* 99, *fig.* 1), inhabits the entire continent, and is one of the most handsome of European birds. His general plumage is of pale reddish purple, contrasting with the deep black of his wings and tail, and the brilliant blue of a few feathers of his wing. To these may be added his quick movements and lively habits, which altogether make him quite an ornament to the woods. He builds on high old trees, and when taken young is easily tamed.

There are about twenty-five species of American jays, of which the crested jay or jay bird of the United States is a familiar example (*G. cristatus*). This elegant bird is peculiar to North America, and is distinguished by the brilliancy, or perhaps gaudiness, of his plumage, which is very agreeably variegated with blue, black, and white. He is very loquacious and capricious in his manners, and so remarkable for his odd gestures that he may appropriately enough be called the fop of the American forest.

Steller's jay (*G. stelleri*) and several other species inhabit western North

America, but the majority of the species are natives of South America and Mexico.

Sub-fam. 3. *Callæatinæ, or Tree Crows.* Bill short, much curved, compressed; wings short, rounded; tail lengthened; tarsi and toes rather long, scaled.

A small group of fifteen or twenty birds found in Asia and Africa. They are represented as partaking in some measure of both crow and jay-like characters, frequenting open places or skirts of the forest or on the ground, and feeding on fruits or small animals. They are birds of very plain plumage, and unattractive general characters and appearance. *Temnurus leucopterus* and *rufus* are frequently seen in collections from India.

Sub-fam. 4. *Corvinæ, or Crows.* Bill long, large, broad at base, curved, with projecting plumes at base; wings long, rounded; tail rather long; tarsi and feet strong. Size various, frequently large, color generally black.

Contains the ravens, crows, magpies, and nutcrackers. Of the ravens about ten species are known, which inhabit all parts of the world except South America. The raven of Europe, *Corvus corax* (*pl.* 98, *fig.* 12), has been observed since the earliest period of history. He is found in all parts of the old world, and inhabits all climates, braving the cold of polar regions or the heat of the tropics. In the eating line nothing comes amiss to him, for he can accommodate himself to fruits or insects if he cannot obtain his favorite grain or recently dead animal matter.

The raven is said to be the most long-lived of birds, having been known to live nearly a hundred years. His voice is peculiarly harsh and startling, and with his black plumage has induced various superstitious notions respecting him. His sudden appearance near a human dwelling has been regarded as especially portentous, as expressed in Othello:

> "It comes o'er my memory
> As doth the raven o'er the infected house,
> Boding to all."

The American raven is very similar in all respects to that of Europe. He is met with in all mountainous districts of North America, and in the winter frequently resorts to the shores of both the Atlantic and Pacific oceans. He is much more abundant, however, on the Pacific side of North America. There appear to be no superstitious ideas amongst the Indians attached to this bird.

Several other Ravens are known, one of which, a large species of Southern Africa (*C. albicollis*), though the greater portion of his plumage is perfectly black, has the back pure white.

The common crow of Europe (*C. corone*) is a species which inhabits the entire continent, and is next in size to the raven amongst the European birds of this genus. The hooded crow, *C. cornix* (*pl.* 98, *fig.* 13), is another common European species. His plumage is unlike the greater number of crows, being ashy grey, having the head and tail only black. The jackdaw, *C. monedula* (*pl.* 98, *fig.* 11), is, however, the best known of

all the European crows on account of his forward and familiar habits. The rook (*C. frugilegus*) is another common species.

No American bird is more universally known than the crow of the United States (*C. americanus*), though nowhere favorably regarded. He is constantly to be observed at all seasons, but much more abundant in the Atlantic States during winter. It would be difficult to find a winter landscape without the crow as a conspicuous feature.

The fish crow (*C. ossifragus*) is the only other species inhabiting the United States. He is a small species, being little larger than the jackdaw of Europe, and is never seen far from the sea side, where he subsists principally on fishes washed up by the waves.

Of the magpies there are eight or ten species. The magpie of Europe, *Pica caudata* (*pl.* 98, *fig.* 10), is a good example. It is rather a favorite throughout Europe, and a constant attendant on cultivation. In captivity this bird is very remarkable for a propensity to steal, which even extends to the purloining of silver plate and other articles of no possible service to its wants.

There are two American species intimately resembling the European species, the American magpie (*P. hudsonica*) and the yellow-billed magpie (*P. nuttallii*), both of which are natives of the western side of North America. They will probably adopt the familiar and acquisitive habits of the European bird when their native country shall have become more fully settled; but are yet represented as rather shy and unobtrusive birds, though resembling in form and color of plumage the common magpie to such an extent as to be scarcely distinguishable.

Of the nutcrackers there are three species, one of which is common in Europe, *Nucifraga caryocatactes* (*pl.* 99, *fig.* 2), though rare in Great Britain. It frequents wooded regions, feeding on the kernels of nuts and on insects. It breeds in a hole of a decayed tree, and in climbing sometimes assumes the attitude and appearance of a woodpecker.

Two other nutcrackers have been discovered in India. The only American bird which appears to be very nearly related to them is *Corvus columbianus*, or Clark's crow, which is found in the Rocky Mountains and western North America. It was discovered by the exploring party of Lewis and Clark, but little is yet known of its history.

Many other species of crows are known which are scattered over the entire surface of the globe.

Sub-fam. 5. Gymnoderinæ, or Fruit Crows. Bill strong, straight, rather depressed; wings long, pointed; tail moderate, rounded; tarsi and feet long. Size smaller.

Six birds only constitute this sub-family. They are natives of South America, and are represented as found exclusively in the vast forests of that continent, feeding on berries and other fruits. The red-breasted crow (*Pyroderus scutatus*) is as large as the common crow, and has the plumage perfectly black, with a wide belt on the breast which is deep red, giving this bird a very remarkable appearance.

The umbrella chatterer (*Cephalopterus ornatus*) also belongs here. Its

plumage is shiny black, and it has a very peculiar and elegant crest rising from the top of the head and spreading somewhat like an umbrella.

The other species of this group are the bald-headed crows, which have the part indicated by the name entirely naked. Their habits appear to be much like those of the common American or European species.

Sub-fam. 6. *Pyrrhocoracinæ, or Choughs.* Bill long, slender, and curved; wings lengthened, pointed; tail long; tarsi and feet rather short and strong. Size moderate; color black.

This sub-family contains four species only, of which the chough of Europe (*Pyrrhocorax alpinus*) is found in the mountains of that continent, where in the summer it lives in the regions approaching the greatest altitude, but in the winter descends to the lower countries. Its food consists of insects, worms, and seeds. It is said to breed in the remote recesses of the mountains, and to construct its nest in the fissure of a rock.

The red-legged chough (*Coracia gracula*) is another European species very similar to the last.

There is no representative of these birds yet discovered in America; the two other birds of this sub-family are natives of Africa and Australia.

FAM. 2. STURNIDÆ, OR STARLINGS. Bill more or less long, compressed, often with an angle near the base of both mandibles; wings generally long and pointed; tail generally long; tarsi and feet more or less robust; claws frequently well developed. Size small.

An extensive family, containing all the birds known as grakles, starlings, hanging birds, troopials, and many others. Very many of the species are exceedingly gregarious and appear in vast flocks, of which those of North America, known as blackbirds, are familiar illustrations.

Sub-fam. 1. *Ptilonorhynchinæ, or Glossy Starlings.* Bill moderate, strong, compressed; wings moderate, pointed; tail various, frequently long; tarsi strong, with scales; toes rather long and robust. Size moderate.

The splendid starlings or shining thrushes, as they were formerly called, of Africa are arranged here. Twenty-five species are known, nearly all of which are remarkable for the brilliant metallic tints of their plumage, which is frequently dark. *Ptilonorhynchus nitens* and *P. chrysotis* are common in collections brought from Liberia and Sierra Leone. These birds inhabit the entire continent of Africa, and partake of the general characters of the American blackbirds, by which name they are known to the colonists.

Several similar Australian and Indian genera are classed here.

Sub-fam. 2. *Graculinæ, or Grakles.* Bill long, strong, broad at base, compressed to the tip; wings long; tail short, sometimes moderate; tarsi rather short, robust; toes rather long, strongly scaled. Size small.

This sub-family does not comprise the birds known in the United States as grakles, but is restricted to some five or six species of Asia and its islands.

The mino bird (*Gracula religiosa*) is best known. It is a native of India, and possesses considerable powers of song. It is a heavy-formed bird, of black plumage, with very singular appendages on the sides of its

head, capable of being erected. It is frequently brought from India living, and can be taught to articulate words with great exactness.

The African beef-eater, *Buphaga africana* (*pl.* 99, *fig.* 14), is arranged here. It is a plain-plumaged little bird, only remarkable for the fact that it follows herds of buffaloes and other animals for the purpose of preying upon the larvæ of insects which infest them, for which purpose it alights upon their backs.

Sub-fam. 3. *Sturninæ, or Starlings.* Bill rather long, frequently straight, sometimes curved; wings moderate, sometimes rather long; tail short; tarsi and feet long, robust. Size various, frequently small.

An assemblage of about fifty species of birds which are distributed throughout the surface of the globe. The common starling of Europe, *Sturnus vulgaris* (*pl.* 100, *fig.* 1), lives in the fields, having apparently a partiality for marshy or wet places. It walks on the ground in search of its food, which consists of seeds, worms, and insects. There are several birds of this sub-family, which are abundant in Asia and Africa, one of which visits the South of Europe. It is the rose-colored starling, *Pastor roseus* (*pl.* 100, *fig.* 11), one of the most beautiful of this family, having the entire plumage of a delicate rose red, except the head and crest, which are shining black.

The American larks belong here. The well known species, *Sturnella ludoviciana* (*pl.* 99, *fig.* 15), frequents every pasture field and meadow to a greater or less extent throughout the United States. It lives almost entirely on the ground, and constructs a very ingenious oven-shaped nest.

There are two other species very nearly related to the common bird, one of which (*S. neglecta*) is found in the Rocky Mountains and the country westward, the other (*S. hippocrepis*) inhabits Mexico. A beautiful species (*S. militaris*) is found in South America, which considerably resembles the common lark, except that instead of the yellow under surface of the body it has those parts very handsome of a reddish pink color.

Sub-fam. 4. *Quiscalinæ, or American Grakles.* Bill lengthened, curved; wings moderate, pointed; tail lengthened, graduated, with the sides frequently curved upwards; tarsi and feet long and robust. Size various; color black.

This sub-family contains about twenty birds, which are strictly confined to America. They are generally seen in immense flocks migrating northwards or southwards according to the season. The purple grakle (*Quiscalus versicolor*), or crow blackbird, is the largest of the species found as far north as Pennsylvania. The rusty grakle (*Q. ferrugineus*) is equally abundant.

There are about a dozen species of Mexico and South America which more or less resemble the last named bird.

Sub-fam. 5. *Icterinæ, or American Orioles.* Bill rather long, straight; wings long, pointed; tail generally rather long; tarsi and feet moderate, or sometimes long. Size various; colors gay, frequently orange or other yellow, and black.

These birds have been called Hang Nests, on account of their constructing pensile or hanging nests like that of the Baltimore oriole or hanging bird of the United States, *Icterus baltimore* (*pl.* 99, *fig.* 16). This bird, which is a good representation of the family, is one of the handsomest and most sociable of the birds of the United States, making his nest almost at the very doors of all farmhouses throughout the country. In addition to his elegant form and brilliant orange and black plumage he has a very agreeable voice, and is a universal favorite.

About fifty other species are found in other parts of the continent of America and the West Indies. They are amongst the most beautiful and graceful of American birds.

Sub-fam. 6. *Agelainæ, or Troopials.* Bill moderate, or rather short, conical, with the culmen flattened, and more or less broad; wings moderate; tarsi and feet rather lengthened and slender; claws strong and sharp. Size small; colors frequently black.

Another sub-family of American birds, all the species of which bear more or less intimate relationship to the red-winged blackbird of the United States (*Agelaius phœniceus*), a bird known to everybody. After passing the winter in the Southern States of the Union it arrives in the North in April, and frequents the vicinity of swampy meadows, or similar situations, where it constructs its nest, and continues to make itself very conspicuous by its oft-repeated and rather agreeable notes, and handsome black plumage and red shoulders. During September, however, the birds of this species assemble in flocks and proceed south.

The cow bird (*Molothrus pecoris*) belongs here. It is a plain little bird with entirely black plumage, remarkable for its partiality for cattle, which it walks after in their pastures, and for the curious habit of depositing its eggs, like the cuckoo of Europe, in the nests of other birds. It is common throughout North America.

FAM. 3. FRINGILLIDÆ, OR SPARROWS AND FINCHES. Bill short, thick, strong, generally conic and angular at the base; wings and tail generally moderate; tarsi and feet usually slender.

An immense family of little birds known as sparrows, finches, tanagers, weaver birds, and by many other names. They inhabit the entire globe, and are more or less numerous in all countries.

Not less than six hundred birds belong to this family.

Sub-fam. 1. *Ploceinæ, or Weaver Birds.* Bill strong, conic, extending slightly on the head; wings somewhat rounded; tarsi and feet robust. Size small.

This sub-family is restricted to Asia and Africa, and comprises numerous species of little birds remarkable for constructing curious bag-shaped nests, for which purpose they use cotton and the fibres of plants. Some of the species are clothed in very brilliant scarlet plumage, as the grenadier grosbeaks (*Ploceus oryx* and *ignicolor*), which inhabit Africa.

The widow birds as they are called, but properly *Whidah* birds, from the name of a place from which they are brought in Western Africa, belong here. The species usually seen in collections are the common widow bird

(*Vidua paradisea*), the king widow bird, *V. regia* (*pl.* 101, *fig.* 7), and the red-billed, *V. erythrorhynchus* (*pl.* 101, *fig.* 8). They appear to be very similar in habits to the little sparrows of the United States.

Sub-fam. 2. *Coccothraustinæ, or Grosbeaks.* Bill large, very strong, broad at the base, conic; wings lengthened, more or less pointed; tail generally short; tarsi and feet rather short and robust.

Contains about forty species of birds, which have the largest and strongest bills of all the birds of this family. They inhabit various parts of the world, subsisting almost exclusively on seeds, for the purpose of obtaining which some of the species employ their strong bills in breaking such fruits as almonds, cherry-stones, &c. Many birds of this sub-family are very showy. The rose-breasted grosbeak of the United States belongs here (*Guiraca ludoviciana*). It is one of the most handsome of American birds, having the entire superior parts shining black, and the lower parts of the body white, with the breast very delicate rose red.

The cardinal grosbeak (*Cardinalis virginianus*) also belongs here. The entire plumage is fine scarlet, except a small space around the bill, which is black; and its high pointed crest gives it a graceful and elegant appearance. The males have loud and musical notes resembling those of a fife, which are constantly heard during the spring. The bird inhabits all North America.

The hawfinch, *Coccothraustes vulgaris* (*pl.* 100, *fig.* 3), is the best known European species. It is a bird of plain plumage inhabiting the entire continent. The green finch, *C. chloris* (*pl.* 101, *fig.* 4), is another common European species.

Other birds of this group are distributed throughout the entire surface of the globe.

Sub-fam. 3. *Tanagrinæ, or Tanagers.* Bill various, generally rather short, somewhat triangular at base, and slightly curved; wings moderate, sometimes pointed; tarsi and feet generally short and rather slender. Size various; colors frequently gay.

A sub-family of American birds, containing some of the most beautiful species which inhabit this continent.

There are about two hundred and fifty species of tanagers, of which two only visit the Northern States in the summer. The best known is the scarlet tanager, or black-winged red-bird (*Pyranga rubra*), a beautiful bird with very brilliant scarlet plumage except the wings, which are deep black. It appears in Pennsylvania about the first of May, and lives during the summer almost exclusively in the woods, rarely approaching the habitations of man, though not very shy or timid.

The other northern species is the summer red-bird (*P. estiva*), which is entirely purplish red, though not so showy as the former bird.

Vastly the larger number of these birds inhabit South America, where they live in all descriptions of localities, generally perhaps preferring low trees and bushes in the vicinity of water. They feed indiscriminately on insects, fruits, and seeds. The bishop tanager (*Tanagra episcopus*) is a common and singularly colored species; it is of a light blue, with a shading of greyish white.

Several of the handsome crested tanagers are common in collections, especially the scarlet crested species (*Tachyphonus cristatus*), which is a bird about the size of the orchard oriole, with the plumage entirely black except a brilliant erect scarlet crest. The most richly colored birds of this large sub-family are, however, the paradise tanagers. Of these, perhaps, the most beautiful is a species sometimes called the seven-colored tanager, *Calliste tatao* (*pl.* 101, *fig.* 11), which has the plumage of that number of distinct colors. Another is the tricolored tanager (*C. tricolor*), which has three colors, blue, green, and orange. Many other species have very gay and agreeably colored plumage, though said to possess little or no song.

The Towhe buntings or chewinks are arranged here, of which one species (*Pipilo erythrophthalma*) is very common in the United States.

Sub-fam. 4. *Fringillinæ, Sparrows and Finches.* Bill short, conic, compressed to the tip; wings generally lengthened and pointed; tail various, usually rather lengthened and rounded; tarsi and feet generally long and slender. Size small.

An extensive group, comprising about two hundred and fifty little birds, found in all countries. They are well known everywhere for their familiar and harmless habits, and general disposition to frequent the vicinity of cultivated places or the abodes of man. They feed on seeds and fruits, and many species live habitually on the ground.

There are several European species, among the most common of which are the house-sparrow, *Fringilla domestica* (*pl.* 100, *fig.* 6 *a*); the mountain sparrow (*F. montana*); the chaffinch, *F. cœlebs* (*pl.* 101, *fig.* 12); the brambling (*F. montifringella*), and some others.

The North American species are the white-throated sparrow (*Zonotrichia albicollis*), the song sparrow (*Z. melodia*), the white-crowned sparrow (*Z. leucophrys*), the grass sparrow (*Z. graminea*), the rush sparrow (*Z. juncorum*), the chipping sparrow (*Z. socialis*), the fox sparrow (*Z. iliaca*), and a number of others less common.

The song sparrow, and the chipping sparrow or *chippy*, as it is usually called, are perhaps the most abundant birds in the United States. The former may be met with almost every day in the year in all hedges or in the neighborhood of small water-courses; and the latter, in all the gardens and orchards, fields and meadows, of the whole country. Both are plain-plumaged, but very agreeable little birds, possessing very pleasant voices, and are great favorites with our rural population.

The goldfinches belong here. The best known European species is the common goldfinch, *Carduelis elegans* (*pl.* 101, *fig.* 10); another is the siskin, *C. spinus* (*pl.* 101, *fig.* 9). The American species are the thistle bird (*C. tristis*), the western goldfinch (*C. psaltria*), the Mexican goldfinch (*C. mexicana*), Lawrence's goldfinch (*C. lawrencei*), and several others.

Many other little birds of all countries are arranged in this group. The amaduvat, *Fringilla amaduva* (*pl.* 101, *fig.* 6), is an Indian species; the little Senegal finch, *F. senegala* (*pl.* 101, *fig.* 5), inhabits Africa.

Sub-fam. 5. *Emberizinæ, or Buntings.* Bill conic, acute, lateral margins sinuated, interior of upper mandible furnished with a knob-like projection from the palate; wings moderate, rather pointed; tarsi and feet rather long and slender. Size small, but generally larger than the preceding.

This sub-family contains about sixty species of birds, considerably resembling those of the preceding in general characters and appearance. They are natives of all countries of the globe, but principally the northern and temperate regions.

The black-throated bunting (*Emberiza americana*) inhabits the whole of the United States. It is a very pretty bird, with plumage striped brown above and pale yellow beneath the body, with the throat black. It lives almost exclusively in meadows where the grass is most abundant, in which it constructs its nest. It is remarkable for being one of the very first birds that leaves for the south towards the end of summer, and before there is any decrease of temperature or appearance of autumn. This bird leaves in August. The European species are the yellowhammer, *E. citrinella* (*pl.* 101, *fig.* 15), the corn bunting (*E. miliaria*), the cirl bunting (*E. cirlus*), the ortolan, *E. hortulana* (*pl.* 101, *fig.* 13), the reed bunting, *E. schœniculus* (*pl.* 101, *fig.* 14), and some others.

Several birds belonging to this group inhabit the high northern latitudes, but occasionally visit the temperate parts of Europe and North America in winter. The snow bunting (*Plectrophanes nivalis*), the Lapland long-spur (*P. lapponicus*), the painted bunting (*P. pictus*), and another species (*P. ornatus*), are the species alluded to.

Sub-fam. 6. *Alaudinæ, or Larks.* Bill usually lengthened and slender, but sometimes short; wings long, with the tertials as long as the primaries; tarsi and feet long, and rather robust; claws long. Size small.

A small sub-family containing the larks of the old continent, and a few American birds known as shore or horned larks.

One European species is very celebrated; it is the skylark, *Alauda arvensis* (*pl.* 102, *fig.* 7), which sings while rising in the air to an immense height, and especially in the early morning. Several other species are also admired songsters, such as the crested lark, *A. cristata* (*pl.* 102, *fig.* 6), and the field lark, *A. calandria* (*pl.* 102, *fig.* 5).

The shore lark or horned lark of the Atlantic portion of the United States (*A. alpestris*) is a bird which is native of the north, and migrates towards the Southern States in the winter, at which time this bird is abundant along the roadsides and other exposed places.

Several species inhabit India and Africa, and appear to be very common in similar situations during their migrations.

These birds must not be confounded with the birds usually called larks in the United States, which do not belong here.

Through the taste and perseverance of some gentlemen of the city of New York the European skylark has been naturalized to a considerable extent in Long Island, and is likely to become a permanent and very agreeable addition to the singing birds of the United States.

Sub-fam. 7. *Pyrrhulinæ, or Bullfinches.* Bill very short, strong, arched,

and convex; wings moderate, somewhat rounded; tail moderate; tarsi and feet rather short and robust. Size small.

Rather less than one hundred birds are arranged here, nearly all of which inhabit northern and temperate regions.

The European bullfinch, *Pyrrhula europea* (*pl.* 101, *fig.* 2), is one of the prettiest little birds of that continent. He is much esteemed as a cage bird, and large numbers are exported from Germany to all parts of the world.

The purple finch (*Carpodacus purpureus*), a common and very handsome American bird, belongs here. The male is of a uniform purple color, though seldom observed, on account of almost exclusively frequenting the forest.

There are several western species, of which the crimson-fronted bullfinch (*C. frontalis*) appears to be most common.

Some ten or twelve little birds of this sub-family, forming the genus *Crithagra*, are peculiar to the continent of Africa. There are a large number of South American species (genus *Spermophila*), of which the thick-billed finch, *S. crassirostris* (*pl.* 101, *fig.* 3), is a good example.

Sub-fam. 8. *Loxianæ, or Crossbills.* Bill rather long, both mandibles compressed towards the tips, which are curved and cross each other; wings lengthened, pointed; tail moderate, emarginated; tarsi and feet short and strong. Size small; color generally purple.

These birds inhabit the forests of pine, fir, or other trees of similar character, in the northern regions of America, Europe, and Asia. The seeds of those trees are readily extracted by their curiously formed bills, and appear to be their principal food.

The parrot crossbill (*Loxia pityopsittacus*), the common crossbill (*L. curvirostra* (*pl.* 100, *fig.* 2), and the white-winged crossbill (*L. leucoptera*), are the European species. The two latter are common in the northern United States.

Several others have been observed in India and other countries of Asia.

Sub-fam. 9. *Phytotominæ, or Plantcutters.* Bill short, strong, broad at base, lateral edges finely serrated; wings moderate; tail rather short, truncate; tarsi strong; toes long and slender.

Three birds of South America constitute this sub-family. They are found in the forests, and occasionally visit gardens and plantations, in which they are said to commit much injury, by a peculiar manner of cutting off buds and fruits. Their notes are represented as very unpleasant, and somewhat similar to the sounds produced by sharpening a saw. The common plantcutter (*Phytotoma silens*), the narrow-billed (*P. angustirostris*), and the rusty plantcutter (*P. rutila*), are the known species.

Sub-fam. 10. *Colinæ, or Colies.* Bill small, elevated at base; wings short; tail very long, graduated; tarsi short and robust; toes lengthened and all directed forwards. Head crested.

This group comprises eight or ten birds, which are natives of Africa. They have a peculiar formation of their feet, by which all the toes (including the hind toe of other birds) are directed forwards, though its use has

not been observed. They feed on fruits and green buds, and build their nests in society, closely together on the same tree. The great-tailed coly (*Colius macrourus*) and the striped coly (*C. striatus*) are frequently seen.

FAM. 4. MUSOPHAGIDÆ. A small family, composed of about fifteen species of birds, which inhabit the torrid zone. They have no representatives in northern or temperate regions.

Sub-fam. 1. *Musophaginæ, or Plantain Eaters.* Bill broad and elevated at base, frequently advancing upon the forehead, compressed towards the tip, and mostly with the lateral margins serrated ; wings short and rounded ; tail long ; tarsi and feet strong. Size larger ; plumage usually gay.

All the birds of this group inhabit Africa, except one, which is found in South America. Many of the species are remarkable for their beauty. They are represented as being timid birds, inhabiting the densest parts of the forest, and perching upon branches of trees longitudinally, like the goatsuckers. They are birds of but limited powers of flight, and have discordant and disagreeable notes. The violet plantain eater (*Musophaga violacea*) and several species with green plumage appear to be common. The South American bird is the crested hoazin of some travellers (*Opisthocomus cristatus*). It is abundant on the banks of the Amazon, living in small flocks, and eating fruits and buds, particularly of some species of *Arum*.

FAM. 5. BUCEROTIDÆ, OR HORNBILLS. A family of large birds, very remarkable for the extraordinary size and shape of their bills. They are strictly confined to Asia and Africa.

About forty species are well established.

Sub-fam. 1. *Bucerotinæ, or Hornbills.* Bill generally very large and lengthened, curved, with the upper mandible furnished with appendages of very various shapes and sizes, sometimes flat and cap-shaped, sometimes curved upwards, crescent-shaped ; wings moderate, rather short ; tail usually long ; tarsi and feet short, strong. Size various, frequently large ; colors generally white and black.

These extraordinary birds are found in the continents and islands of Africa and Asia. The use, if any, of the singular appendages to their bills, has never been discovered, nor even conjectured with any plausibility. It is stated that these birds feed principally on fruits, though occasionally feeding upon dead quadrupeds and sometimes reptiles. Their flight is said to be heavy and noisy, though frequently at considerable height. The nest is formed in the hollow of a tree.

The rhinoceros hornbill, *Buceros rhinoceros* (*pl.* 103, *fig.* 2), is a common Indian species, which has a very large bill and appendage. The red-billed hornbill, *B. erythrorhynchus* (*pl.* 103, *fig.* 1), is a small species, with the bill almost simple.

One large bird of this sub-family, the Abyssinian hornbill (*B. abyssinicus*), which inhabits various countries of eastern and southern Africa, habitually frequents the ground, subsisting in a great measure on large beetles and other insects. It builds, however, in trees, and is said to construct a very large and curious nest, completely covered, having a lateral entrance.

Order III. Scansores

Embraces the Toucans, Parrots, Woodpeckers, and some other families of birds, which are grouped together under the common denomination of climbing birds.

They can be recognised immediately by the peculiar disposition of their toes, which are placed in pairs, two before and two behind. This arrangement, which is characteristic of the order, gives them great facility in climbing on the trunks and about the branches of trees.

The species of this order are not numerous, and principally inhabit warm countries.

Fam. 1. Ramphastidæ, or Toucans. A group of about fifty birds of South and Central America and Mexico. They are all singular and rather grotesque in their appearance, on account of their disproportionately large bills. They are known by the names of Toucans and Aracaris.

Sub-fam. 1. *Ramphastinæ.* Bill very large, long, smooth, broad at the base, curved, compressed to the point, lateral margins finely serrated; wings short, rounded; tail various, sometimes lengthened, frequently short and truncated. Tarsi and feet rather short and strong. Size rather large; colors gay.

The only sub-family contains two genera, *Ramphastos*, or Toucans, and *Pteroglossus*, or Aracaris, the species of which are very similar in habits and history.

These singular birds are represented as being common in the vast forests of South America, though shy and cautious. They feed on various tropical fruits, but are also said to devour reptiles, young birds, and other small animals. They breed in hollow trees, building little or no nest. Several species of these birds have been discovered in Mexico. Nearly all the species possess more or less beauty of plumage, being mostly fine black with red and yellow.

The red-billed toucan (*Ramphastos erythrorhynchus*), the large-billed, *R. tucanus* (*pl.* 97, *fig.* 13), and the long-tailed aracari, *Pteroglossus aracari* (*pl.* 97, *fig.* 12), are the most common species.

Fam. 2. Psittacidæ, or Parrots. This large family of birds, some of which are universally known, is distributed throughout the warmer regions of the world. They are easily recognised by their peculiar general form and plumage, familiar disposition, and the capability of many of the species of being taught to imitate the human voice.

There are about three hundred species of parrots.

Sub-fam. 1. *Pezoporinæ, or Ground Parrots.* Bill moderate, abruptly arched from the base to the tip; wings short; tail long, broad; tarsi and feet short and robust. Size small; colors gay.

These birds inhabit southern Asia and Australia, generally living on the ground or in thickets, or in low woods. Many of them are very richly colored. The ring-necked parrot (*Palæornis torquatus*) of India and the beautiful ground parrot of Australia (*Pezoporus formosus*) are suitable

examples. The red-headed parrot of India, *Palæornis alexandri* (*pl.* 97, *fig.* 4), and the Malacca parrot, *P. malaccensis* (*pl.* 97, *fig.* 3), are also included in this group.

Sub-fam. 2. *Arainæ, or Maccaws.* Bill large, arched from the base to the tip, which is prolonged and sharp ; wings moderate ; tail long, graduated, tip of each feather pointed. Size large ; colors gaudy.

A sub-family of about seventy birds, comprising nearly all the American parrots. The maccaws are large parrots, with very showy plumage, found in the forests of South America, living principally on the fruits which abound in such localities. Their notes, or rather screams, are represented as being very harsh and disagreeable. The common blue and yellow maccaw, *Ara ararauna* (*pl.* 98, *fig.* 2), the military maccaw, *A. militaris* (*pl.* 98, *fig.* 3), and the great blue maccaw (*A. hyacinthina*), are frequently to be seen living in menageries, and appear to be the most common species of this sub-family.

Many other parrots of South America, composing the genus *Conurus*, belong here, some of which have very beautiful red and green plumage. One species only visits the Atlantic States, which is the Carolina parrot (*C. carolinensis*). This bird is frequent in Louisiana and others of the Southern States, and has occasionally been seen as far north as Illinois. It is a very handsome species, with green and yellow plumage, and is generally observed in flocks, on the appearance of which in unusual localities great curiosity is excited amongst the inhabitants. In some sections of the country this parrot is eaten, and considered a great delicacy.

Sub-fam. 3. *Lorinæ, or Lories.* Bill large, slender, arched from the base to the tip, which is prolonged and acute ; wings moderate, sometimes long, pointed ; tail long ; tarsi and feet short, strong. Size small.

A small group of beautiful little parrots found only in India and the islands of the Pacific ocean Little is known of them except that they live in the banana and palm trees, in which they rear their young. *Lorius domicella* (*pl.* 98, *fig.* 4) and *L. tricolor* are frequently seen in collections. An Australian group belongs here, of which the beautiful green parrot, *Platycercus viridis* (*pl.* 98, *fig.* 1), is a good example.

Sub-fam. 4. *Psittacinæ, or typical Parrots.* Bill generally large, broad at base, compressed, arched, lateral margins dentated or festooned ; wings long, pointed ; tail generally short ; tarsi and feet short and strong. Size various ; colors usually gay.

These parrots are found in all the warmer regions of the globe. They mostly inhabit the forests, where they live in pairs or small flocks, climbing among the upper branches of the trees on the fruits of which they live. Some species, it is said, sleep suspended from the branch of a tree with their heads downwards. Nearly all parrots are migratory, and move from place to place in flocks at immense heights in the air. They feed their young by disgorgement like the pigeons.

Nearly all the talking parrots belong here, of which one of the best is the grey African parrot (*Psittacus erythacus*), a plain but very *intelligent* species, common in Liberia and other countries of Western Africa. The

black-headed parrot, *P. melanocephalus* (*pl.* 97, *fig.* 5), is a very fine Indian species. There are many other birds belonging to this group.

Sub-fam. 5. *Cacatuinæ, or Cockatoos.* Bill large, but generally short and very strong; wings generally long; tail long, broad, usually truncate; tarsi short and strong. Size mostly large; colors plain.

This group contains about thirty species, which are restricted to Australia and some of the Indian islands. Many of these birds are large species with pure white plumage and handsome crests, which they can erect at pleasure. These crests are sometimes very finely colored, as in the yellow-crested cockatoo, *Cacatua sulphurea* (*pl.* 97, *fig.* 1), and the citron-crested (*C. citrino-cristata*) and others.

There is another genus of this sub-family which have nearly black plumage, with their tails frequently variegated with red and yellow, such as Banks's cockatoo (*Calyptorhynchus banksii*), and Cook's parrot (*C. cookii*), and others. These are large birds, represented by travellers as being very common and noisy in the forests of Australia.

Fam. 3. Picidæ, or Woodpeckers. A family of about two hundred and fifty birds, which are scattered over the surface of the whole world. They are readily recognised by their straight bills and erect position when perched.

Sub-fam. 1. *Capitoninæ, or Barbets.* Bill large, broad at base, which is usually furnished with bristles; wings moderate, rather short; tail generally short; tarsi and feet short, strong.

The birds of this sub-family are abundant in all tropical countries. They feed on fruits and insects, and make nests in hollow trees or in holes like the woodpeckers. The grooved-bill barbet, *Pogonias sulcirostris* (*pl.* 97, *fig.* 11), is an African species; the green and orange barbet, *Capito viridiaurantius* (*pl.* 97, *fig.* 10), is a native of India.

Sub-fam. 2. *Picinæ, or typical Woodpeckers.* Bill rather long, straight, broad at base, upper mandible with a lateral ridge; wings generally short; tail lengthened, with the feathers pointed; tarsi short, strong; toes long. Size generally small; colors mostly black and white.

The most numerous of all groups of woodpeckers, and comprises birds of all countries. The American species of this sub-family are commonly known by the name of *sapsuckers;* the red-headed woodpecker, which belongs to another sub-family, being the only species called by the name of woodpecker in the United States.

The hairy woodpecker (*Picus villosus*), the downy woodpecker (*P. pubescens*), and the yellow-bellied woodpecker (*P. varius*), are the most common species, though there are several others. They are very active and harmless little birds, always seen in pursuit of insects on the trunks and branches of trees.

There are three common European species, known as *Picus major* (*pl.* 98, *fig.* 8), *P. medius*, and *P. minor*. Many others are natives of Asia and Africa, all of which partake of the same general habits and appearance as those of America. The Cayenne woodpecker, *P. cayennensis* (*pl.* 98, *fig.* 6), is a common South American species.

Sub-fam. 4. *Gecinæ, or Green Woodpeckers.* Bill more or less long, straight, base broad, sides with a lateral ridge; wings long, pointed; tail long; tarsi and feet short and strong. Size larger, color generally green or yellow.

The greater number of the birds of this sub-family are confined to the old world, many of which are large and handsome species, with plumage of various shades of green, and with the top of the head usually bright scarlet. They live entirely in the forests. The green woodpecker of Europe, *Gecinus viridis* (*pl.* 98, *fig.* 7), is a common bird of that continent, everywhere to be seen climbing amongst trees of small growth, and sometimes in hedges and on the ground. There are several Indian species of beautiful plumage; and a few are found in South America which have the plumage of dark brown or cinnamon color, with long crests of pale yellow, such as the citron-colored woodpecker (*Celeus citrinus*) and others.

Sub-fam. 5. *Melanerpinæ, or Black Woodpeckers.* Bill rather long, compressed, with a lateral ridge; wings long and pointed; tail rather long; tarsi and feet short. Size various, color mostly black, or striped black and white.

A sub-family of exclusively American birds inhabiting the entire continent.

The red-headed woodpecker (*Melanerpes erythrocephalus*) is the best known species. "There is, perhaps," says Wilson, "no bird in North America more universally known than this. His tricolored plumage, red, white, and black, glossed with steel blue, is so striking and characteristic, and his predatory habits in the orchards and cornfields, added to his numbers and fondness for hovering along the fences, so very notorious, that almost every child is acquainted with the red-headed woodpecker.

"Wherever you travel in the interior in the summer you hear them screaming from the adjoining woods, rattling on the dead limbs of trees, or on the fences, where they are perpetually seen flitting from stake to stake on the roadside before you. Wherever there is a tree or trees of the wild cherry, covered with ripe fruit, there you see them busy among the branches; he is fond of the ripe berries of the sour gum, and pays pretty regular visits to the cherry trees when loaded with fruit. Towards fall, he often approaches the barn or farmhouse, and raps on the shingles and weatherboards; he is of a gay and frolicsome disposition, and half-a-dozen of the fraternity are frequently seen diving and vociferating around the high dead limbs of some large tree, pursuing and playing with each other, and amusing the passenger with their gambols." He inhabits the whole of North America, passing the winter in the extreme south.

There are two species found in western North America, which are related to the red-headed woodpecker, Lewis's woodpecker (*M. torquatus*) and the red woodpecker (*M. ruber*).

The other birds of this group are peculiar to Mexico and South America.

Sub-fam. 6. *Colaptinæ, or Ground Woodpeckers.* Bill long, curved, broad at base, compressed; wings long; tail rather long; tarsi short; toes long. Size rather large; colors green and yellow.

A group composed of about a dozen American woodpeckers and a few which are natives of India.

The golden-winged woodpecker or flicker of the United States (*Colaptus auratus*) is the best known. He is a very elegant bird, with plumage of dark umber, transversely marked with black on the upper parts of his body, below of very delicate fawn-color, with a broad crescent of deep black. He is well known to our country people and to all amateur sportsmen, who are attracted by his size and handsome appearance, though not very readily shot on account of his easily excited suspicions and quick movements.

Several species intimately resembling the yellow-winged woodpecker have been discovered in California and Mexico.

The Indian species are smaller birds of similar general habits.

Sub-fam. 7. *Yuncinæ, or Wrynecks.* Bill short, straight, acute; wings moderate and pointed; tail moderate, rounded, composed of soft feathers; tarsi and feet short. Size small, colors plain.

Three birds only are contained in this sub-family; the only one of which the history is well known is the wryneck of Europe, *Yunx torquilla* (*pl.* 98, *fig.* 9), so called from its having a peculiar twisting motion of the head and neck. Its principal food is ants, which it obtains by pecking away the earth from about their nests, and then allowing the insects to adhere to its glutinous tongue. It is found throughout Europe.

Fam. 4. Cuculidæ, or Cuckoos. A family of birds very different in form and manner from the preceding climbers, and much more resembling the perching birds. They have, however, the peculiar form of foot which characterizes the other climbers, and by which they may be recognised.

There are about one hundred and fifty species of cuckoos, which are found in all the countries of the world.

Sub-fam. 1. *Indicatorinæ, or Honey Guides.* Bill short, broad at base, curved, compressed; wings long, pointed; tail moderate, emarginated; tarsi and feet short. Size small, colors plain.

Contains about ten little birds of Africa and India, which have obtained the names of honey guides from the fact that they are usually observed in the vicinity of nests of wild bees. The honey from those is said to be their chief food, in the obtaining of which they are frequently attacked by the bees and stung to death. The best known are the greater and smaller honey guides of Africa (*Indicator major* and *minor*), which inhabit Liberia and other countries of Western Africa.

Sub-fam. 2. *Saurotherinæ, or Ground Cuckoos.* Bill long, straight, hooked at the tip, compressed; wings moderate, rounded; tail lengthened; tarsi and feet long and robust. Size rather large.

A sub-family of about six birds only, which are exclusively American. Several species which are found in Mexico and California habitually frequent the ground, on which they run with great swiftness. They are partial to dry, bushy places, and are very shy and difficult to approach. Their food consists of reptiles, insects, and other small animals.

Sub-fam. 3. *Coccyzinæ, or Curved-bill Cuckoos.* Bill arched, com-

pressed, rather long; wings moderate, rounded; tail long; tarsi and feet long. Size small, colors plain.

This group is composed of rather an anomalous collection of Cuckoos, natives of all parts of the world except Europe. Africa and South America produce much the larger number of species.

The two North American cuckoos (*Coccyzus americanus* and *C. erythrophthalmus*) belong here. The former, or yellow-billed cuckoo, is quite frequently seen and oftener heard, as it is most generally perched in a tree of thick foliage, and has a loud note. It is a plain-colored though rather elegant-looking bird, with glossy drab plumage above and pure white below, arriving early in May in the northern States. Unlike the cuckoo of Europe this bird has sufficient regard for its reputation to have a home of its own, which is generally constructed in the orchard or an isolated fruit tree. Its note is something similar to the syllables *kow-e*, rapidly repeated, from which it has acquired the name of "cow-bird" in some districts.

The red-eyed or black-billed cuckoo is not so numerous, but very similar in habits and appearance.

Sub-fam. 4. *Crotophaginæ, or Anis.* Bill rather long, arched, and much compressed; wings short, rounded; tail long, broad; tarsi and feet long. Size various; colors generally dull, sometimes black.

This assemblage of birds is confined to tropical regions, and is composed of about twenty species of very dissimilar general appearance.

The American species, or anis, as they are usually called, are black birds with singularly compressed and elevated upper mandibles, in fact having the appearance of a prominent appendage in front. They inhabit the West Indies and South America, being partial to cultivated grounds, pastures, and meadows, through the thickest grass of which they readily make their way by means of their ploughshare-like bills, in pursuit of grasshoppers and other insects on which they subsist. The common ani (*Crotophaga ani*), the greater ani (*C. major*), and the grooved-bill ani (*C. sulcirostris*) are common species. The latter has been observed in Mexico.

Sub-fam. 5. *Cuculinæ, or Cuckoos.* Bill broad, curved, compressed; wings long, pointed; tail long, graduated; tarsi short, feet strong. Size rather large; colors various.

A large sub-family, entirely confined to the old world. Nearly all the species are found in the warmer regions of Asia and Africa, two only being regarded as properly European birds. They are the crested cuckoo (*Oxylophus glandarius*) and the common cuckoo (*Cuculus canorus*).

The latter is one of the birds of Europe which has attracted attention from the earliest period, and has found a place in the literature of all European nations. He is a plain-plumaged bird, of deep bluish grey above, and white with blackish bars beneath the body.

"There are few birds," as Sir William Jardine observes, "which have excited so much interest as the common cuckoo. Its note in spring heralding the return of sunny skies and bursting vegetation, carries with it dear associations in every country where it is known; while the singular provision of its making use of the nests of other birds in which to deposit its

eggs has created an interest and curiosity to ascertain its history. It has been ascertained without doubt that the European cuckoo and several foreign species deposit their eggs in the manner we have alluded to, not attending afterwards to the fate of the egg nor to the after-rearing of the young. In choosing the nest for the reception of its eggs, it has been remarked that those of insect-eating birds (like itself) chiefly are selected. The young bird is endowed with a remarkable feeling to get rid of its companions in the nest, which is continued, it is said, for twelve days; after which time, if it has been unsuccessful in its efforts, it remains quiet and at peace with its neighbors. It is attended to for a certain time by its foster parents, and afterwards left to itself. The young remain in the summer longer than the old birds, as we have frequently seen them late in August, at which time they utter a note or whistle very dissimilar to the cuck-oo of the love season."

The cuckoo is spread over the whole of Europe, decreasing in numbers in the north. It subsists entirely on insects.

Several other species have been discovered in Asia and Africa, very similar in appearance to the common bird, and they are supposed to be also similar in habits and history.

Several small African species, sometimes called golden cuckoos (*Chalcites auratus*, and others), have very splendid golden-green plumage, and are the most beautiful of this family. One of these is worthy of special notice from the fact that it was named by the celebrated naturalist and traveller Le Vaillant in honor of a faithful Hottentot servant who accompanied him during one of his expeditions, and continues to be known by his name, as "Klaas' cuckoo" (*C. klaasii*).

Order IV. Columbæ, Pigeons and Doves.

Contains an assemblage of birds of elegant forms, and much isolated in appearance and general characters from all other birds. They are said to live almost invariably in pairs, and one of their chief characters is that they feed their young by disgorging the food previously swallowed by the parent.

All the species are known by the names of pigeons and doves, and they inhabit all the countries of the world.

Fam. 1. Columbidæ (only family).

Sub-fam. 1. *Treroninæ, or Tree Pigeons.* Bill short, ends of both mandibles knobbed or thickened; wings moderate, strong; tail broad, truncate; tarsi very short, generally feathered, feet robust. Size rather large; colors gay.

The birds of this sub-family are restricted to India and the Asiatic islands. Many of them are large and showy, living entirely in trees and mostly found in the depths of the forests, on the fruits obtained in which they subsist.

The aromatic pigeon (*Treron aromatica*), an Indian species, is remark-

able on account of its plumage having a spice-like flavor. One genus of this group (*Ptilonopus*) contains several species found in the islands of the Pacific, which have very fine green and red plumage, and are amongst the most handsome of the pigeons.

Sub-fam. 2. *Columbinæ, or Pigeons.* Bill moderate, slender, base covered with a tumid skin; wings moderate, pointed; tail various, generally ample and truncate; tarsi short, feet robust. Size various.

This assemblage contains all the familiar birds of Europe and North America usually known by the names of pigeons and doves, as well as many others only known to inhabit the wilds of Asia and Africa. The European species are the best known, one of which is the original of the domestic pigeon. It is the rock pigeon, *Columba livia* (*pl.* 96, *fig.* 12), a bird common in many parts of Europe, living and rearing its young in the holes or fissures of rocks. It is abundant in many places on the coasts of England and Scotland. Its manners are represented as very similar to those of the domesticated pigeon; when in search of food it walks with facility, and has the same manners and gestures during courtship as may be observed in the common bird of the city. The rock dove has the entire plumage plain, dark-lead color, with a white space on its back. All the pigeons known as tumblers, croppers, carriers, fantails, and many others, are considered as being derived from this one species.

The blue-backed dove, *C. œnas* (*pl.* 96, *fig.* 13), is a species nearly allied to the preceding. The ringdove (*C. palumbus*) is the largest of the European species. It has never been domesticated.

One of the most elegant as well as favorite European species is the turtle-dove, *C. turtur* (*pl.* 96, *fig.* 15). It is a plain little bird with greyish-blue plumage, spending the summer in central and southern Europe, and migrating southwards in the autumn. It lives in the woods, and its notes in the spring are peculiarly sweet and plaintive.

Several North American pigeons belong here, the largest of which are several species found in the Rocky Mountains and the western territory of the United States. But there is no species so universally known, nor which appears in such numbers, as the passenger pigeon or wild pigeon (*Ectopistes migratorius*), a bird which is distributed throughout the United States. It is a very graceful and handsome plumaged bird, with dark lead-colored plumage above and reddish beneath the body.

"The multitudes of wild pigeons," says Audubon, "in our woods are astonishing. In the autumn of 1813 I left my house at Henderson, on the banks of the Ohio, on my way to Louisville. A few miles beyond Hardensburgh I observed the pigeons flying in greater numbers than I thought I had ever seen them before, and feeling an inclination to count the flocks that might pass within the reach of my vision, I dismounted, and found that 163 flocks passed in twenty-one minutes. I travelled on, and still met more the further I proceeded. The air was literally filled with pigeons, the light of noonday was obscured as by an eclipse, and the continued buzz of wings had a tendency to lull my senses to repose."

Another and great favorite is the Carolina or turtle-dove (*E. caroli-*

nensis), a plain, but very pretty bird, frequently to be seen in the woods and fields, and like the turtle of Europe it is one of the first to announce the advent of spring by its harmonious but rather melancholy cooings.

Many other birds belong here, of the greater part of which little is known.

Sub-fam. 3. *Gourinæ, or Ground Pigeons.* Bill moderate, rather slender, straight, apex strong; wings moderate, pointed; tail moderate, rounded; tarsi and feet rather long, robust. Size very various.

Contains a large number of pigeons which live habitually on the ground. They are most numerous in tropical countries, though a few species have been discovered to inhabit the extreme southern limits of the United States in summer. Of these the Zenaida dove (*Zenaida amabilis*) is one of the most remarkable. It occasionally visits Florida, and is said to be very gentle in its manners, and to possess a voice of remarkable softness.

The little bird-like dove (*Chamæpelia passerina*) is another, which has been observed in Florida, and more abundant than the preceding. It is a very small species, and is often tamed.

The two largest birds of the family of pigeons belong to this assemblage. They are the crowned pigeon and the queen's pigeon (*Goura coronata* and *G. victoria*), both of which are considerably larger than common fowls. They are much alike in general appearance, having fine ashy blue plumage and beautiful erect crests, and inhabit the large islands of the Indian archipelago.

Numerous other beautiful pigeons and doves belong here, which are found in all warm countries. *Goura cruenta* (*pl.* 96, *fig.* 14) is an Indian species.

Sub-fam. 4. *Didinæ, or Dodos.* Bill longer than the head, much curved towards the tip, which is hooked and acute; tarsi short, robust; feet strong; wings and tail unknown. Size large.

This sub-family has been founded on one bird only, which is called "the dodo" by some early voyagers to the island of Mauritius, which it formerly inhabited. It is now supposed to be extinct, and no perfect specimen is known to exist, though several fragments are preserved in European museums. It is represented as having been a large bird, somewhat resembling a turkey, and to have lived on the ground in the forests of palm trees, on the fruits of which it subsisted.

Order V. Gallinæ.

This order consists of the common fowls, pheasants, grouse, turkeys, and other birds of similar manners and character. They are invariably formed essentially for living upon dry ground. Their food, with few exceptions, is entirely vegetable, and their chief support is derived from the seeds and grains of plants. Many of them eat also the green or leafy portions, and are in this respect nearly peculiar among birds. Almost all of them have large crops or *craws*, and extremely muscular and powerful gizzards.

The Gallinæ are for the greater part very sociable birds, and many species are readily domesticated. They are more practically useful to man than all other birds together.

FAM 1. CRACIDÆ, OR CURASSOWS. A family of birds principally found in Mexico and Central America, and known by the names of curassow birds, penelopes, guans, Mexican turkeys, and others.

There are about thirty-five species.

Sub-fam. 1. *Penelopinæ, or Guans.* Bill moderate, slender; nostrils large; wings short, rounded; tail long; legs and feet long and robust; sides of the head and throat more or less naked. Size large.

These birds inhabit South America, mostly residing in the forests and subsisting on fruits and insects, which they are represented as pursuing in the morning and evening. They construct their nests in trees, and are habitually wary and difficult to approach. The crested penelope (*Penelope cristata*) appears to be common.

Sub-fam. 2. *Cracinæ, or Curassows.* Bill generally long, curved, compressed; wings short, rounded; tail long; tarsi and feet very strong and lengthened; head crested. Size large.

The curassow birds are found mostly in Mexico and Central America, in the countries of which they are domesticated to some extent, and hence are sometimes called Mexican turkeys. They are large birds, generally of plain black plumage, with erect handsome crests. The red curassow, *Crax rubra* (*pl.* 96, *fig.* 10), is one of the species frequently met with.

FAM. 2. MEGAPODIDÆ. A small family of about twelve or fifteen species of birds inhabiting Australia and the Pacific islands. They are large birds, having very thick and strong legs, and short curved bills, said to live mostly on berries.

Sub-fam 1. *Tallegallinæ.* Bill moderate, rather robust, curved towards the tip; wings moderate, rounded; tail long; tarsi very thick and lengthened; feet robust. Size large.

Contains three birds only, which are natives of Australia and New Guinea, where they have acquired the name of bush turkeys. They are mostly observed in small flocks on the ground, and when apprised of danger seek safety by running into the deepest thickets, or into the recesses of the forest. The bush turkey of Australia (*Tallegallus lathami*) is the only common species in collections.

Sub-fam. 2. *Megapodinæ, or Mound Birds.* Bill moderate, rather weak; wings short, rounded; tail rather short; tarsi and feet very robust. Size smaller.

The birds of this sub-family are found only in the Asiatic islands and Australia. Some of the species, particularly one which inhabits Australia (*Megapodius tumulus*), build very curious mounds of a large size for the purpose of depositing their eggs therein. These mounds have been observed upwards of twenty feet in circumference and ten feet high, and are composed of sand and vegetable matter.

FAM. 3. PHASIANIDÆ, PHEASANTS, PEACOCKS, AND FOWLS. All the birds

of this family are restricted to the old world. They are the most beautiful of the gallinaceous birds, and have no superiors in the whole feathered creation.

Few of these birds have been domesticated, and they are generally not highly prized for other qualities than their beauty of plumage.

Sub-fam. 1. ***Pavoninæ, or Peacocks.*** Bill moderate, compressed, curved: wings short, rounded; tail long, with the upper tail coverts very much lengthened and extending beyond the tail; tarsi long, robust; feet strong. Size various, generally large; colors generally very beautiful.

This sub-family is composed of some of the most magnificent of birds. The peacocks, of which there are two species, belong here; both inhabit India and its islands, and they present plumage certainly not surpassed by that of any other known birds.

We find the splendor of the common peacock, *Pavo cristatus* (*pl.* 96. *fig.* 5), mentioned at a very early period. It attracted the notice of the mariners of Solomon, in the time of whom it appears to have been well known. It was afterwards discovered by the army of Alexander, by whom it was so much admired that he imposed a penalty on its destruction. Hence it became known to Greece, Rome, and to Europe generally.

Peacock shooting is a favorite amusement in India, where in some districts they are abundant. "About the passes in the Jungletery district," says Colonel Williamson, "I have seen such numbers of pea fowls as have absolutely surprised me. Whole woods were covered with their beautiful plumage, to which a rising sun imparted additional brilliancy. The small patches of plain among the long grass, most of them cultivated, and with mustard then in bloom, which induced the birds to feed, increased the beauty of the scene; and I speak within bounds when I assert, that there could not have been less than twelve or fifteen hundred pea fowls of various sizes, within sight of the spot where I stood for near an hour.

"When they are in numbers scattered in a jungle it is easy to get a shot, but I have always found much difficulty when the birds flock together, as they frequently do, to the amount of forty or fifty. At such times it is not easy to raise them. When on the wing, they fly heavy and strong, generally within an easy shot; but if only winged, they speedily recover, and if not very closely pursued will nine times out of ten disappear."

It is worthy of notice that domestication has not changed the appearance of the peacock in the slightest degree, though nearly all other birds and quadrupeds have been more or less subject to variety from this source.

The other known species is the Java peacock (*P. muticus*), of which little is known, though it is now frequently seen in museums. It has the neck brilliant green instead of blue as in the common species, and differs in other respects, though presenting a similar general appearance. It is not domesticated.

Another superb bird of this group, scarcely inferior in beauty to the pea-

cocks, is the Argus pheasant, *Argus giganteus* (*pl.* 96, *fig.* 8). It is a native of Sumatra, and is supposed also to inhabit continental Asia as far north as China. In size the Argus is not much superior to the common fowl, but the great length of the wing and tail feathers makes it appear much larger. It is almost impossible to convey by description only any idea of the blending of colors in this magnificent bird. The throat and cheeks are naked. The lower part of the body is reddish-brown, every feather regularly spotted with yellow and black; the upper parts are covered with large black spots separated by lines of ochre-yellow; the upper tail coverts are clear yellow and the tail deep chestnut. The wing feathers are spotted with green and shades of brown in the most beautiful manner. The Argus has not been domesticated.

The diamond pheasant (*Polyplectron chinguis*) and several other birds of splendid plumage are arranged here, nearly all of which are natives of India.

Sub-fam. 2. *Phasianinæ, or Pheasants.* Bill moderate, strong, straight, and slightly arched at the tip; wings short, rounded; tail greatly lengthened; tarsi and feet very strong. Size various; colors generally very beautiful.

Another group of splendid birds exclusively belonging to the old world. The pheasant of Europe, *Phasianus colchicus* (*pl.* 96, *fig.* 6), now distributed over the entire continent, is well ascertained to have been introduced from Asia by the ancient Greeks. Its plumage is of the most beautiful glossy chestnut color, with black crescent-shaped marks. Its favorite haunts are thick or tangled woods near streams, where it passes the night, but betaking itself to the open fields during the day in search of food. It walks and runs much in the same manner as the common fowl, which it greatly resembles in its manners.

The most beautiful of pheasants and one of the most splendid of birds is the golden pheasant, *P. pictus* (*pl.* 96, *fig.* 7), which is a native of China. Its plumage is almost entirely of golden yellow, barred with red and black. It is called in China "kinki," or golden-flower fowl, and is kept extensively in domestication.

The silver pheasant (*P. nycthemerus*) is another fine species. Its entire plumage is beautiful silvery white with black lines, and the head adorned with a long crest of glossy purple feathers.

The fire-backed pheasant (*Euplocomus ignitus*) and several other species of the same genus belong here, as do also the curious and very handsome horned pheasants, of which the most common species is the golden-breasted, *Tragopan hastingsii* (*pl.* 96, *fig.* 9). They have fine red and white plumage, and are peculiar for possessing fleshy protuberances about the head resembling horns. They are also Asiatic birds, but are little known.

Sub-fam. 3. *Gallinæ, or Fowls.* Bill moderate, curved towards the tip; wings moderate, rounded; tail lengthened, frequently compressed and arched; tarsi and feet robust and rather long. Size smaller than preceding; colors gay.

This group is composed of species of wild cocks from several of which the domestic poultry is probably derived. They are all natives of India and the adjacent islands, frequenting the forests. They are remarkable for their pugnacity, especially when questions regarding their females have to be settled, and all the species crow in a manner more or less resembling the cock of the farmyard.

It is difficult to determine which of the wild species have been domesticated, as varieties of the latter occur which resemble several, though naturalists are apparently quite justified in pointing out at least two species, which are the Malay cock (*Gallus giganteus*) and the jungle cock (*G. bankiva*). The former is a large and rather clumsy bird, long domesticated in the islands of Java and Sumatra, and is very probably the original stock of all the large and more peaceable birds of the common fowl (*pl.* 95, *figs.* 10, 11).

The jungle cock is the forefather of the gamecock, and joint progenitor of many and various colored crossbreeds between it and the offspring of the Malay cock, and possibly of others. He inhabits continental India, and is clothed in fine red and golden orange plumage, much resembling that of the well known game birds, though he is considerably smaller. This species is yet abundant in the forests and jungles of India, in which country he has been domesticated from time immemorial. There are, however, no traces of the manner or period in which he was introduced into Europe, though known familiarly at the earliest date of recorded history, both as a delicacy for the table and for his pugnacious character.

Cockfighting was carried to a great extent by the Hindoos long prior to the invasion of Alexander, but seems originally to have partaken somewhat of the character of a religious rite, as did many games. This amusement was practised by the ancient Greeks and Romans, and by them transmitted to modern times.

The bronzed cock (*G. æneus*), the fork-tailed cock (*G. furcatus*), and Sonnerat's cock (*G. sonneratii*), are other species which also inhabit India.

Sub-fam. 4. *Meleagrinæ, or Turkeys.* Head and neck bare, and generally hairy and carunculated; bill moderate, strong; wings short; tail moderate; tarsi and feet very robust. Size various, frequently large; colors dark.

This sub-family comprises the turkeys, of which there are two species, and the Guinea fowls, of which there are five.

The common turkey, *Meleagris gallopavo* (*pl.* 95, *fig.* 12), is a native of the forests of North America, and was formerly distributed throughout the entire country. It has now, however, become extinct or nearly so in the States on the Atlantic seaboard, but is still abundant in the west and south. The turkey is strictly gregarious, and flocks of several hundreds are generally seen together; their movements from place to place are entirely performed on foot, and when apprehensive of danger they usually trust to their legs rather than resort to flight. It is said, however, that they are capable of flying a short distance with great swiftness, and that when their progress is impeded by a river, after a considerable delay and exami

nation, they ascend to the tops of the neighboring trees, and at the *cluck* of their leader launch into the air for the opposite shore. Their favorite food consists of acorns and other nuts found in the forest, but they also devour with avidity Indian corn, berries, insects, lizards, and in fact almost anything capable of sustaining life. Since the discovery of America the turkey has been extensively domesticated in all civilized countries.

Another and very beautiful species of turkey has been discovered within a few years in Honduras. Its habits and manners are little known, but represented as very similar to the common species. It is domesticated among the inhabitants of Central America, and is probably extensively diffused over the country in a wild state.

The Guinea fowls are natives of Africa, where they frequent the forests principally in the neighborhood of rivers. They associate in flocks of many hundreds, and are said to commit great depredations on the crops of the colonists and natives. Their food consists of grain, rice, grasshoppers, and various insects. Several species of wild Guinea fowl are found in Liberia and other countries of Western Africa.

The common species, *Numida meleagris* (*pl.* 95, *fig.* 13), is abundant in the country from which it has taken its name. There are several other and larger species, none of which have been domesticated.

Sub-fam. 5. *Lophophorinæ, or Shining Pheasants.* Bill moderate, broad at base, upper mandibles projecting; wings moderate; tail large and broad; tarsi and feet rather short, but very robust. Size rather large; colors metallic and very handsome.

A few beautiful birds of the Himalayah Mountains compose this group, the most splendid of which is the fire pheasant (*Lophophorus refulgens*). Its plumage has a deep black for its ground color, but with metallic tints of every hue. It is said to be abundant in the ranges of the Himalayah Mountains and to take wing readily, uttering a loud whistle, and that its food consists principally of bulbous roots and insects.

Fam. 4. Tetraonidæ, or Grouse and Partridges. Is composed of the birds familiarly known by the names of grouse, partridges, quails, and others, all of which are frequently alluded to as game birds. They are generally birds of plump form and with plumage of dull colors. Their flesh is highly esteemed as an article of food.

Sub-fam. 1. *Perdicinæ, or Partridges of the Old World.* Bill short, curved; wings moderate, rounded; tail short; tarsi and feet moderate, but strong. Size generally small; colors plain.

Contains all the partridges of the old world, of which there are nearly seventy species. These are most abundant in India and other countries of Asia, two only being found in Europe. Of these the red partridge, *Perdix rubra* (*pl.* 96, *fig.* 4), is the larger, and one of the handsomest birds of the genus. It is found plentifully in the South of Europe, where it inhabits cultivated grounds, and is hunted like the other species.

The grey partridge, *P. cinerea* (*pl.* 96, *fig.* 3), is the smaller of the European species, but is abundant throughout the continent. It is a plain-colored but elegant bird, living in fields or other cultivated places, and is

one of the few birds which do not appear to diminish in numbers on account of the proximity of man. All the other species seem to be quite similar in their general habits to the two birds here mentioned.

Sub-fam. 2. *Turnicinæ, or Quails.* Bill moderate, straight, compressed; wings short, rounded; tail short, almost concealed by the long feathers of the back; tarsi moderate, strong. Size quite small; colors plain.

These birds are found in the South of Europe, India, Africa, and Australia. They have much the same habits as the partridges, which they resemble in appearance, though they are much smaller. They live entirely on the ground, running with great swiftness, and seeking their food amongst the grass and other herbage. The common quail of Europe, *Turnix dactylisonans* (*pl.* 95, *fig.* 15), is distributed throughout the continent and Asia.

Sub-fam. 3. *Odontophorinæ, or American Partridges.* Bill short, curved to the tip, upper mandible slightly prolonged; wings moderate, rounded; tail rather long; tarsi and feet moderate. Size various; colors various, frequently gay.

This sub-family embraces the partridges of America, of which there are about thirty-five species, mostly natives of Mexico and Central America. One of the most beautiful of these is the California partridge, *Lophortyx californicus* (*pl.* 96, *fig.* 11), which is a common bird in that country. This and other species of these elegant birds seem to prefer the sandy plains or open woods, generally living in bands of several hundred individuals, and seeking their food on the ground. There are numerous species of these birds found in California and Mexico, some of which are amongst the most beautiful of the birds of North America.

The common partridge of the United States (*Odontophorus virginianus*) is spread over the whole of North America. It rarely frequents the forest, but is most partial to the cultivated plantations where there is plenty of grain. When not too much persecuted by gunners this pleasant bird becomes almost half-domesticated, in winter approaching the barn and outhouses, and feeding amongst the poultry of the farmyard. Buckwheat is a particular favorite, in the fields of which the partridge may almost invariably be detected. His note in the spring is somewhat similar to the words "Bob White," which has been given to him for a name, and by which he is extensively known.

Sub-fam. 4. *Tetraoninæ, or Grouse.* Bill short, rather broad, curved; nostrils covered; wings moderate, rounded; tail wide, sometimes rounded or forked; tarsi rather short, feathered; feet strong; size various, frequently large; colors generally plain.

These birds are residents of the northern parts of both continents; inhabiting all descriptions of localities, but rather preferring barren or bushy plains. They are in much request as articles of food, and are much sought after by hunters and sportsmen.

The largest species is the cock of the woods, or capercailzé, *Tetrao urogallus* (*pl.* 96, *fig.* 1), a European species, formerly abundant but now more rare, and entirely extinct in Great Britain. It is not much inferior to

the turkey in size, and has fine black plumage. It is yet frequently met with in the forests of the north of Europe.

The moor cock, *T. tetrix* (*pl.* 96, *fig.* 2), is another fine European species, formerly very abundant, and yet frequent in the Highlands of Scotland. It is entirely black with a forked tail, and is represented as living principally on twigs and buds of the heath and on blades of grass.

Several species of these birds inhabit the United States, of which the largest is the cock of the plains (*T. urophasianus*). The others are, the sharp-tailed grouse (*T. phasienellus*), the Canada grouse (*T. canadensis*), the dusky grouse (*T. obscurus*), and the prairie hen (*T. cupido*). The latter was formerly abundant throughout the United States, but is now almost extinct in the Atlantic states. The most common species is, however, the ruffed grouse or pheasant, *T. umbellus*, which is frequent throughout the country.

The most curious birds of this group are the ptarmigans, which live in the extreme north of both continents. They are usually seen on the barren grounds, or among thickets of willows and birches, on the banks of marshes or lakes. The plumage varies with the season; in the winter they are pure white, but as the spring advances they assume a dark chestnut color, which gradually extends over the whole body. The white ptarmigan (*Lagopus albus*) is a frequent species in the north of Europe, and the rock ptarmigan (*L. mutus*) in northern America. In the winter season, when alarmed, they are said to plunge into the snow, under which they proceed to considerable distances.

Sub-fam. 5. *Pteroclinæ, or Sand Grouse.* Bill short, curved, compressed; wings and tail long and pointed; tarsi and feet robust and feathered; size small; colors plain.

These singular birds inhabit the sandy deserts of Africa and Asia, and nearly all the species have their plumage of dull brown, much resembling the color of dry sand. Their food consists of hard seeds, grass, and insects. The banded sand grouse (*Pterocles bicinctus*) is frequently brought from Africa; the desert grouse, *P. alchata* (*pl.* 95, *fig.* 14), is another species.

Sub-fam. 6. *Tinaminæ, or Tinamous.* Bill rather long and slender; wings short, rounded; tail very short, rounded; tarsi and feet moderate and strong. Size various; colors plain.

About twenty-five species of these birds are known, all of which are found in South America. Their general appearance is much that of a partridge with a long bill, and their habits and manners are said to be very similar. The larger tinamou (*Tinamus major*) and others are common.

Order VI. Struthiones.

This order embraces the ostrich, the cassowary, the bustards, and a few other birds, mostly of large size.

Fam. 1. Struthionidæ, or Ostriches. The only family of the order, the species of which are easily distinguished by their large size and exclu-

sive organization for walking. About thirty birds are included in this family.

Sub-fam. 1. *Struthioninæ, or Ostriches.* Bill broad, flattened, somewhat rounded; wings and tail very short; tarsi very long and robust; toes two or three in number, and all directed forwards. Size large.

The ostrich, *Struthio camelus* (*pl.* 94, *fig.* 1), which is the largest of all birds now known to be living, is arranged here. It inhabits the open plains of Africa, where it is sometimes observed in large flocks, especially when the herbage is abundant, as that forms its chief food. When alarmed, it runs with great rapidity, with the assistance of its wings. The nest is a slight hollow scratched in the sand, and, it is said, is generally occupied by two females, both of which lay their eggs, and with the males attend mutually to the young.

The South American ostriches, of which there are two species, *Rhea americana* and *darwinii,* are frequent on the plains of Patagonia and the other more southerly countries of South America. They are much smaller than the ostrich of Africa, but bear considerable resemblance in general appearance and manners.

The emu of Australia (*Dromaius novæ hollandiæ*) and the cassowary of New Guinea, *Casuarius galeatus* (*pl.* 95, *fig.* 1), complete the birds of this group. They are both large birds, almost destitute of wings, but are said to run with great rapidity. They feed exclusively on vegetables.

Sub-fam. 2. *Apteryginæ, or Kivis.* Bill long and slender; wings and tail very short, almost obsolete; tarsi and feet short and robust; entire plumage hair-like.

Two very curious birds found in New Zealand belong here. They frequent the extensive and dense beds of ferns which occur in that country, and feed on snails and insects. The plumage of these birds is very singular and peculiar, being composed of long feathers more resembling the hair of some quadrupeds than the covering of birds. The common kivi, *Apteryx australis,* and Owen's apteryx, *A. owenii,* are the known species.

Sub-fam. 3. *Otinæ, or Bustards.* Bill rather long, straight; wings and tail moderate; tarsi long, robust; toes short. Size various, rather large.

The bustards are found in the sandy or grassy plains and the open cultivated lands of various countries of the old continent. They are shy and watchful, and when alarmed, fly with considerable swiftness for a short distance, then running off. They feed on seeds and other parts of vegetables, and are said to be very destructive to crops of wheat and other grain in some parts of Asia and Africa. The great bustard, *Otis tarda* (*pl.* 94, *fig.* 2), was formerly frequently seen throughout Europe, but has now become rare. It is the largest known species, and was a favorite bird with sportsmen, as are many species of other countries. The smaller bustard, *O. tetrax* (*pl.* 94, *fig.* 3), is found occasionally in the south of Europe, but principally in northern Africa. There are about twenty species of these birds, nearly all of which inhabit northern Africa and Asia.

Order VII. Grallæ, or Waders.

With this order we enter upon the birds which habitually reside in the neighborhood of water, and are usually denominated water birds, in contradistinction to those which live habitually on the dry land.

This rather extensive order is composed of birds recognised immediately by their long legs and long necks, and by their constantly being observed in search of fishes and other aquatic animals, which they mostly pursue by wading into shallow waters. A few species, however, content themselves with such animals as are to be found on the shores or on dry land.

The herons, storks, snipes, woodcooks, curlews, and other birds of such appearance and habits, belong here.

Fam. 1. Charadriadæ. Comprises all the plovers, turnstones, oyster-catchers, &c. They are generally small and timid birds, living on the banks of inland streams, in the neighborhood of ponds or lakes, or the shores of the ocean.

Sub-fam. 1. *Œdicneminæ, or Runners.* Bill rather long, somewhat curved to the tip; wings long, pointed; tarsi long; toes three only, directed forwards, and rather small; tail short. Size rather small; color plain.

A small group of birds, which reside in the warmer regions of both continents. One species, the thick-leg (*Œdicnemus crepitans*), visits the south of Europe, frequenting open fields, and feeding in the evening or at night. It is said to remain squatted behind a stone, or any other object admitting of concealment, during the day. Other birds of this sub-family are found in the plains and deserts of Africa and Asia, such as the *Cursorius senegalensis*, and others.

Sub-fam. 2. *Glareolinæ, or Pratincoles.* Bill short, broad at base, compressed; wings very long; tarsi and feet moderate; tail short. Size small.

About seven species of very peculiar birds compose this sub-family. They inhabit the temperate and warmer parts of the Old World, subsisting on flies and other insects, which they take on the wing, like swallows, and on the ground. The European pratincole, *Glareola torquata* (*pl.* 95, *fig.* 5), is the only well described species.

Sub-fam. 3. *Charadrianæ, or Plovers.* Bill long, slender, depressed; wings long, pointed; tail moderate, frequently broad; tarsi long, slender; feet rather small. Size various, generally small.

Rather an extensive assemblage of about one hundred species of birds, embracing all the lapwings and plovers which inhabit the whole surface of the globe. The European lapwing, *Vanellus cristatus* (*pl.* 93, *fig.* 2), is spread over the entire continent, and is remarkable for its graceful form and rapid flight, which is at times performed with numerous singular evolutions in the air, and accompanied by a series of oft-repeated notes. The golden plover of the United States (*Charadius pluvialis*) belongs here, as does also the kill-deer plover (*C. vociferus*), Wilson's plover (*C. wilsonius*), and some others. The plover of Europe, *C. auratus* (*pl.* 93, *fig.* 1), is a common and handsome species.

Sub-fam. 4. *Hæmatopinæ, or Oyster-catchers.* Bill long, strong, and much compressed; wings long, pointed; tarsi and feet very robust; tail short; size larger; colors mostly black and white.

The species of this sub-family are distributed in most parts of the world. They live on the sea-shores, subsisting on the animals of sea-shells, which they obtain by inserting their compressed wedge-like bills between the valves. They build on the bare sands, or in such scanty herbage as may be found growing near the reach of high water. The best known species are the European oyster-catcher (*Hæmatopus ostralegus*), and the American oyster-catcher (*H. palliatus*). The latter is frequently met with on the shores of the Atlantic.

Sub-fam. 5. *Cinclinæ, or Turnstones.* Bill short, straight, and rather acute; wings long; tail short; tarsi rather short; toes long. Size small; colors mostly red, and black and white.

Four or five curious little birds are arranged here. They frequent the sea-shores of all parts of the world, feeding entirely on such shell-fish and other small animals as are thrown up by the waves, and are said to turn over small stones in quest of insects with much dexterity. The common turnstone, *Cinclus interpras* (*pl.* 95, *fig.* 7), is abundant in Europe, while the American species (*C. melanocephalus*) is quite as abundant in America.

Fam. 2. Ardeidæ. Another large family, containing the cranes, herons, storks, and ibises. They inhabit every country of the world, and may generally be readily distinguished by their long necks and legs, and attenuated general appearance. They are mostly birds of large size.

Sub-fam. 1. *Psophinæ, or Trumpeters.* Bill moderate, rather short; wings and tail short; tarsi long; feet moderate. Size large; color dark.

The trumpeters, so called from their loud notes, inhabit South America, where they are found in damp or marshy places in the forests. They seem to partake somewhat of the character of gallinaceous birds, and some species have very handsome plumage. The common trumpeter (*Psophia crepitans*) is frequently seen in collections.

Sub-fam. 2. *Gruinæ, or Cranes.* Bill long, straight, strong; wings rather long, with the tertial quills lengthened and pendent; tail short, pendent; tarsi very long, slender. Size large; colors plain.

The cranes are large birds, usually partial to marshes or swamps, though frequently seen on dry plains. They regularly migrate to the warmer regions during autumn and winter, and in summer return to the north. Their flights are performed during the night in large flocks, under the direction of a leader, and at such a great elevation that they are invisible to the naked eye, though their loud cries may be distinctly heard. Their nests are usually made amongst the herbage of marshy places, and are raised above the surface of the ground, sometimes to the height of the body when standing. The crane of Europe, *Grus cinerea* (*pl.* 93, *fig.* 3), and the American hooping crane (*G. americana*), are examples of these birds.

The crowned crane, *Balearica pavonina* (*pl.* 94, *fig.* 4), is an African species.

Sub-fam. 4. *Ardeinæ, or Herons.* Bill long, acute, much compressed;

wings long; tail short, truncate; tarsi long, slender. Size large; colors plain.

A sub-family containing about one hundred birds, distributed throughout the world. They are usually seen walking over the surface of marshy grounds in quest of small quadrupeds or reptiles, or standing in shallow pools, quietly waiting the approach of fishes, which they capture by suddenly darting upon them with their powerful bills. They build their nests in trees. The purple heron, *Ardea purpurea* (*pl.* 93, *fig.* 5), is one of the European species, as is also the pigmy heron, *A. ralloides* (*pl.* 93, *fig.* 12). The most common American species is the great heron (*A. herodias*), which is one of the largest wading birds of the United States.

The egrets form a distinct genus, distinguished readily by their beautiful snowy white plumage, of which the snowy heron of the United States, *Egretta candidissima* (*pl.* 93, *fig.* 6), is an example.

The bitterns, which belorg here, are noted for their loud and peculiar cries. The best known are the European bittern, *Botaurus stellaris* (*pl.* 94, *fig.* 5), and the American species, *B. minor.*

The spoonbills are also arranged here. They are large birds, with beautiful rose colored and white plumage; and their name has been derived from the singular form of the bill, which is expanded and flattened at the end, somewhat resembling a spoon. The roseate spoonbill, *Platalea leucorrhodia* (*pl.* 93, *fig.* 4), is a native of Southern Europe and Africa.

Sub-fam. 4. *Ciconinæ, or Storks.* Bill long, straight, rather thick, and somewhat conical; wings long and ample; tail moderate, broad; tarsi lengthened; feet moderate. Size large.

A small group of about twenty birds which, with one exception, reside only in the old world. In tropical countries, some of the storks frequent the vicinity of towns and villages, feeding on the offal cast into the streets. They are, however, usually observed stalking about plains or marshy districts in quest of reptiles or other small animals. The Bengal adjutant (*Ciconia argala*) is protected by law in some of the cities of India, in consideration of his services as a scavenger.

The white stork of Europe, *Ciconia alba* (*pl.* 93, *fig.* 7), is a bird of sociable and mild disposition, held in much popular respect on account of its utility in destroying snakes and other animals usually considered noxious, and is easily tamed. In Turkey and other eastern countries, it is considered a sacred bird, and its destruction is strictly prohibited. The stork is known to have the singular habit of sleeping while standing on one leg, holding the other drawn up amongst the feathers of the abdomen, which is also the habit of the American sand-hill crane. The great Audubon made the curious discovery that the latter invariably rested on the same one, or, as he pleasantly expresses it, "has a favorite leg for resting upon."

The black stork (*C. nigra*) is another European species.

The only American species allied to the stork is the *Mycteria americana*, found in South America.

Sub-fam. 5. *Tantalinæ, or Ibises.* Bill lengthened, slender, curved, compressed; wings rather long; tail moderate; tarsi usually rather long,

robust; toes long; size mostly rather large; colors usually gay, sometimes with metallic lustre.

About twenty-five species of handsome birds form this sub-family, which inhabit all countries, and resemble in general characters the herons and storks. The North American species are the wood ibis (*Tantalus loculator*); the scarlet ibis (*Ibis rubra*), which is clothed in beautiful scarlet plumage; the white ibis (*I. alba*); and the Mexican ibis (*I. falcinellus*). There are, however, several South American species. The crested ibis, *I. cristatus* (*pl.* 95, *fig.* 3), is an Asiatic species.

The most distinguished species of all these birds is the Egyptian ibis (*I. religiosa*), which was held sacred by the ancient Egyptians, and is found embalmed in immense numbers. It is yet found inhabiting the banks of the Nile. The large white ibis (*I. alba*) is another African species.

Fam. 3. Scolopacidæ. Embraces the snipes, godwits, avocets, sandpipers, and other birds, which frequent the shores of both salt and fresh waters. They are easily recognised by their small size, long, slender bills, and long legs, and are shy and harmless in their dispositions. Several species are esteemed as delicate articles of food.

Sub-fam. 1. *Limosinæ, or Godwits.* Bill long, slender, curved; wings long and pointed; tail short; tarsi long, slender; toes long. Size larger than usual in this family; colors plain.

About twenty-five species of these birds, known by the names of godwits and curlews, inhabit the various countries of the world. Those resident in the United States are the great marbled godwit (*Limosa fedoa*); the smaller godwit (*L. hudsonica*); the long-billed curlew (*Numenius longirostris*); and the northern curlew (*N. borealis*). The rufous godwit, *L. rufa* (*pl.* 93, *fig.* 9), and the curlew, *N. arcuatus* (*pl.* 94, *fig.* 7), are European species.

Sub-fam. 2. *Recurvirostrinæ, or Avocets.* Bill long, slender, compressed, sometimes curved upwards; wings long, pointed; tail short; tarsi very long. Size various, never large; colors varied.

The avocets and stilts, which are the birds constituting this group, are distributed throughout the globe. The former have the bill curved upwards very decidedly; the latter but slightly, and are remarkable as being the longest legged birds, in proportion to the size of their bodies, of any of the waders; hence they have derived their name. The European avocet, *Recurvirostra avocetta* (*pl.* 93, *fig.* 10); the American avocet (*R. americana*); the European stilt, *Himantopus albicollis* (*pl.* 95, *fig.* 6); and the American black necked stilt (*H. nigricollis*), are common species.

Sub-fam. 3. *Tringinæ, or Sandpipers.* Bill long, slender, compressed; wings long, pointed; tail moderate, truncate; tarsi generally long and slender, sometimes rather short; toes long. Size mostly small.

An assemblage of about fifty little birds which inhabit the sea shores as well as the borders of lakes, rivers, and small inland streams of all countries. It is on the sea shore, however, that they are most abundant, and may constantly be seen running into the advancing waves, or during the recess

of the tide, ever busy in quest of minute shell-fish and other small marine animals upon which they subsist.

Several species are found on the Atlantic coast of the United States, of which the rufous sandpiper, *Tringa rufescens* (*pl.* 95, *fig.* 4), and the pigmy sandpiper (*T. minuta*), are good examples. Others inhabit the small lakes and the borders of small streams, such as Bartram's sandpiper (*Totanus bartramius*), and the spotted sandpiper (*T. macularius*). There are several European species, of which the common sandpiper, *T. calidris* (*pl.* 94, *fig.* 8), and the green sandpiper, *T. ochropus* (*pl.* 94, *fig.* 13), are examples.

Sub-fam. 4. *Scolopacinæ, or Snipes.* Bill long, straight, rather slender: wings moderate, pointed; tail short, rounded; tarsi long; toes long, slender. Size larger.

These birds frequent swampy woods and forests, or open marshes and borders of rivers. The snipe of Europe, *Gallinago major* (*pl.* 93, *fig.* 8), and the grey snipe of the United States (*G. wilsoni*), are good examples of this group.

The woodcocks belong here. There are two species only, one of which, *Scolopax rusticola*, is diffused throughout the old world, while its relative, the American woodcock (*S. minor*), is restricted to North America. Both are in much request by sportsmen, and in high esteem as delicacies for the table.

Sub-fam. 5. *Phalaropinæ, or Phalaropes.* Bill rather long, straight, and slender; wings long, pointed; tail short; tarsi short; toes moderate, and semi-webbed or lobed. Size small: colors handsome.

The few birds composing this group inhabit the north of both continents. They are usually observed in small parties swimming on the borders of the sea, or of lakes or ponds, which they are enabled to do with great facility, by means of their curiously lobed feet. The northern phalarope (*Phalaropus hyperboreus*), and Wilson's phalarope (*P. wilsoni*), are often met with.

Fam. 4. Palamedeidæ. A limited family, comprising a few tropical birds remarkable for their very large tarsi and feet, and otherwise singular forms.

Sub-fam. 1. *Palamedeinæ, or Screamers.* Bill short, curved, wings lengthened, with the shoulders furnished with spurs; tail moderate, tarsi long, very robust; toes lengthened. Size large.

The birds of this group are peculiar to South and Central America, frequenting marshes and the borders of lakes and rivers. They are said to have very discordant voices. The horned screamer, *Palamedea cornuta* (*pl.* 95, *fig.* 2), a common species, has a singular projecting, horn-like protuberance from its forehead, and its wings armed with curved, acute spurs, which it is said to use defensively with great readiness.

Sub-fam. 2. *Parrinæ, or Jacanas.* Bill long, slender, straight; wings long, pointed; tail short; tarsi long, slender; toes very long, slender; shoulders armed with spurs. Size small.

These singularly footed birds are found in the warmer parts of the world. The extraordinary length of their toes and claws enables them to walk over the plants that float on the surface of the water while seeking their food, which consists principally of aquatic insects. The chestnut-colored jacana

(*Parra jacana*), and the Indian jacana, *P. indica* (*pl.* 94, *fig.* 9), are suitable examples and common species.

FAM. 5. RALLIDÆ. This family contains a large number of birds, which are more aquatic in their habits than any of the preceding, and live almost exclusively in marshes. The American and European species are known by the names of rails, crakes, coots, mud-hens, and gallinules.

Sub-fam. 1. *Rallinæ, or Rails.* Bill various, frequently short, straight, sometimes long, curved; wings short, rounded; tail short; tarsi and feet long, slender. Size mostly small; colors plain.

The rails and crakes inhabit all parts of the world, taking refuge in marshes and the thick vegetation of the margins of rivers, through which the peculiarly compressed form of their bodies enables them to pass very readily. They also swim and dive with much ease. There are several European species, such as the dusky rail, *Rallus aquaticus* (*pl.* 95, *fig.* 8), and the corn crake, *R. crex* (*pl.* 95, *fig.* 9). The American species are the Carolina rail (*Ortygometra carolina*), the little black rail (*O. jamaicensis*), the New York rail (*O. noveboracensis*), the clapper rail (*Rallus crepitans*), and the river mud-hen (*R. elegans*).

Sub-fam. 2. *Galkinulinæ, or Gallinules.* Bill short, upper mandible advancing on the forehead, compressed; wings short, rounded; tail short; tarsi and toes long and slender. Size larger; colors generally gay.

These are amongst the most richly colored birds in this order. They are natives of the warmer and temperate regions, and are represented as being less aquatic than many of the preceding tribes. The genus *Porphyrio*, which is classed here, contains numerous species, nearly all of which have their plumage of deep blue color, such as the hyacinth gallinule, *Porphyrio hyacinthinus* (*pl.* 94, *fig.* 11).

The coots also belong to this group. They are remarkable for their curiously lobed feet, which seem to give them an intermediate character between the wading and swimming birds. The black coot (*Fulica atra*) is the European species; the only species found in the United States is the American coot (*F. americana*).

ORDER VIII. ANSERES, OR SWIMMING BIRDS.

This order contains all the birds which have the feet webbed and are otherwise prepared to inhabit the water, upon the surface of which the majority of species pass the greater part of their lives. They usually have the tarsi placed more posteriorly than is the case with those which compose the other orders, so much so that some species can walk only with difficulty. The toes in all the birds of this division are connected by a membrane, which thus forms the instrument by which swimming is accomplished, in addition to which many species have their bodies and plumage admirably constructed for living in their favorite element.

FAM. 1. ANATIDÆ. This family comprises the flamingoes, geese, swans, and ducks.

Sub-fam. 1. *Phœnicopterinæ, or Flamingoes.* Bill large, compressed, suddenly bent downwards in the middle; tarsi very long, slender; toes short and webbed. Size large; colors usually scarlet and white.

These singular birds are natives of the warmer parts of the world. They are usually observed on the sea shore or in the salt marshes, in flocks of many individuals, one of which, it is said, acts as sentinel while the others are feeding or resting. They are very shy birds, and have very handsome scarlet and white plumage. The unusual form of the bill enables these birds to search for small shell-fish and other animals in the sands or marshes by a process resembling *hoeing*. The scarlet flamingo, *Phœnicopterus ruber* (*pl.* 93, *fig.* 11), is an American species, common on the banks and at the mouths of the great rivers of South America, and which occasionally visits Florida. There are four other species.

Sub-fam. 2. *Anserinæ, or Geese.* Bill about as long as the head, sloping to the tip, which has a large, broad nail, compressed, and with the marginal laminæ apparent; wings long; tarsi short; toes short and strongly webbed. Size large; colors plain.

There are about forty species of geese, which are natives of all parts of the world. On the land they walk with facility, and are very buoyant and graceful on the surface of the water. They possess great power and rapidity of flight, and in their migrations mostly move in two lines meeting in a point anteriorly, which is supposed to be always occupied by an experienced leader.

The domestic goose is principally derived from the grey goose (*Anser ferus*), an European species, which appears formerly to have been abundant throughout that continent, but is now much more rare. The white-fronted goose (*A. albifrons*) is also probably the ancestor of some of the varieties of the domesticated bird. It is an inhabitant of both Europe and America, and breeds in the north of both continents. These two species resemble, to a greater or less extent, in appearance and habits the geese of the farm-yard; but many other species have been tamed in different countries, and in fact nearly all the geese appear to be capable of domestication. The other European species are, the bean goose, *A. segetum* (*pl.* 92, *fig.* 7), the pink-footed goose (*A. brachyrhynchus*), the barnacle goose (*A. leucopsis*), so called from the ridiculous idea which formerly prevailed, that it was hatched from a shell called the barnacle, the red-breasted goose (*A. ruficollis*), the Egyptian goose (*A. ægyptiaca*), and some others.

The most common wild goose of the United States is the Canada goose (*Anser canadensis*), which migrates northwards in the spring and returns in autumn, during both of which journeys it attracts great attention on account of its peculiarly formed flocks when flying, and its loud cries. "The flight of the wild goose," says Wilson, "is heavy and laborious, generally in a straight line or in two lines approximating to a point (like the letter V); in both cases the van is led by an old gander, who every now and then pipes his well known *honk*, as if to ask how they come on, and the *honk* of 'all's well' is generally returned by some of the party. Their course is in a straight line, with the exception of the undulations of their

flight. When bewildered in foggy weather they appear sometimes to be in great distress, flying about in an irregular manner and for a considerable length of time over the same quarter, making a great clamor. On these occasions, should they approach the earth and alight, which they sometimes do to rest and recollect themselves, the only hospitality they meet with is death and destruction from a whole neighborhood already in arms for their reception. Wounded geese have in numerous instances been completely domesticated, and readily pair with the tame grey goose. The offspring is said to be larger than either, but the characteristic marks of the wild goose still predominate."

Another large American species is the snow goose, *A. hyperboreus*, which is entirely white. It is not so frequently seen as the Canada goose, but occasionally is shot on the Atlantic coast and in the rivers. The other American geese are the brant (*A. bernicla*) and some others which are also European species. Other geese are inhabitants of Asia and Africa.

Sub-fam. 3. *Cygninæ, or Swans.* Bill about the length of the head, covered at base with a soft cere; wings moderate; tail short; tarsi moderate; feet large; neck very long. Size large, color mostly white.

There are about ten species of swans inhabiting various countries of the globe, but principally distributed in the northern latitudes. They live on the lakes and rivers generally in small parties, subsisting on various aquatic plants. There are several European species, one of which, the mute or tame swan, *Cygnus olor* (*pl.* 91, *fig.* 7), is well known as being almost domesticated. "This species," observes Sir William Jardine, "is chiefly known as an ornament on our rivers and artificial waters, and at a very early period of our history so much importance was attached to having these birds that laws were enacted, and it required a certain qualification and sometimes royal consent for persons to keep them on their domain." At the enumeration of these birds in 1843 the number owned by Queen Victoria in the various lakes and waters of the grounds attached to her palaces was 232, a fact which shows the high estimation in which it is yet held as an ornamental bird. The other European species are the hooper swan, *C. ferus* (*pl.* 91, *fig.* 8), Bewick's swan (*C. bewickii*), and the Polish swan (*C. immutabilis*).

There are two American species, the trumpeter swan (*C. buccinator*) and the western swan (*C. americanus*). The former is frequently met with in the waters throughout the whole country, the latter is more western and southern in its range. They much resemble in history the European swans. In California and Oregon a large species is found which has a black neck and back (*C. nigricollis*). An entirely black swan inhabits Australia, *C. atrata*.

Sub-fam. 4. *Anatinæ, or Fresh Water Ducks.* Bill rather long, broad, depressed, lateral margins lamellated; tarsi short, compressed; feet large. Size smaller than the preceding, colors various.

This sub-family contains about seventy-five species of ducks, all of which habitually live in fresh waters though occasionally seen on the seashores, and reside in all countries.

The origin of the common domestic duck is the mallard, *Anas boschas* (*pl.* 92, *fig.* 8), a species which inhabits both Europe and America. It is very abundant in some districts of the United States in the winter, and is shot and otherwise captured in large numbers. It has been domesticated for many centuries, and is now in the western United States frequently taken young and reared in the farmyard. The other species of North America are the dusky duck (*A. obscura*), the gadwall (*A. strepera*), the widgeon (*A. americana*), the pintail duck (*A. acuta*), the shoveller (*A. clypeata*), the green-winged teal (*A. carolinensis*), the blue-winged teal (*A. discors*), and the summer or wood duck (*A. sponsa*). The latter is the most beautiful of the American ducks, and has no superior in its class except the mandarin duck of China, *A. galericulata* (*pl.* 92, *fig.* 9). The summer duck inhabits the whole of North America, and unlike any other species makes its nest in a hollow tree, sometimes at considerable elevation. Nearly all the American species are found in Europe, though a few are peculiar to the latter continent, as the European teal, *A. crecca* (*pl* 91, *fig.* 10).

The musk duck or Muscovy duck, as it is mostly called (*A. moschata*), belongs here. It is a native of South America, and is extensively domesticated.

Sub-fam. 5. *Fuligulinæ, or Sea Ducks.* Bill rather lengthened, sometimes short, elevated at base; wings moderate, pointed; tail generally short; tarsi short; toes long and fully webbed. Size various, colors often gay.

About forty species are arranged here, which live almost exclusively in salt water, subsisting on shell fish, crustacea, fishes, and marine plants. The most celebrated species is the canvas-back duck (*Fuligula valisneria*), which is esteemed as a great delicacy for the table. It inhabits the whole of North America. There are several other North American species, such as the pochard or red-headed duck (*F. ferina*); the scaup or black-headed duck (*F. marila*); the ring-necked duck (*F. rufitorques*): the ruddy duck (*F. rubida*); the velvet duck (*Oidemia velvetina*), which has its entire plumage of fine black resembling velvet; the surf duck (*O. perspicellata*); the scoter, *O. americana* (*pl.* 91, *fig.* 9); the king duck (*O. spectabilis*); a large species, the eider duck (*O. molissima*), remarkable for the softness of its feathers; the golden eye (*Clangula americana*); the western duck (*C. dispar*); the buffel-headed duck (*C. albeola*); a very handsome and common small species, the harlequin (*C. histrionica*); the long-tailed duck or south southerly (*Harelda glacialis*), and some others.

Nearly all the species here mentioned are also found in Europe.

Sub-fam. 6. *Merginæ, or Mergansers.* Bill straight, slender, elevated at base and covered towards the tip, lateral margins serrated; wings moderate, pointed; tail short; tarsi short; toes moderate. Size various; colors generally rather gay and agreeable.

About ten species only constitute this group. They are birds of very singular appearance, being apparently ducks in all respects except their narrow and lengthened bills. They inhabit the northern portions of both

hemispheres, where they remain until the lakes and rivers are entirely covered with ice, when they return to more temperate regions. They subsist almost entirely on fishes and other aquatic animals which they catch by diving. The merganser or large sheldrake (*Mergus merganser*), the red-breasted merganser (*M. serrator*), and the hooded merganser, *M. cucullatus* (*pl.* 92, *fig.* 10), are the species common to the shores of North America and Europe. Another, which is occasionally observed, is the white merganser (*M. albellus*).

Fam. 11. Colymbidæ. A small group containing the divers and grebes, birds which live almost entirely in the water, rarely venturing on the land. They have the legs inserted more posteriorly than any other swimmers, which enables them to move on the water with great velocity.

Sub-fam. 1. *Colymbinæ, or Divers.* Bill long, straight, compressed, very acute; wings long, pointed; tail short; tarsi short, compressed; toes long, fully webbed before. Size large.

Three birds only belong here. They breed within the arctic circle, but migrate to more temperate climates during winter, and are usually observed on the rivers and lakes swimming in search of aquatic animals which constitute their food. They swim and dive with great facility and swiftness, and are able to remain a long time under water, exposing only the bill or part of the head when they return to the surface. The great northern diver or loon, *Colymbus glacialis* (*pl.* 91, *fig.* 3), the black-throated diver (*C. arcticus*), and the red-throated diver (*C. septentrionalis*), are the known species.

Sub-fam. 2. *Podicepinæ, or Grebes.* Bill rather long, straight, compressed, tip acute; wings short; tail very short or rudimental; tarsi short, compressed; toes long and broadly lobed. Size smaller.

There are about twenty-five species of grebes, which are scattered over the world, and usually observed near the sea-coast. They are excellent swimmers and divers, and are said to pursue fishes to a considerable depth in the water. The crested grebe, *Podiceps cristatus* (*pl.* 91, *fig.* 1), the horned grebe (*P. cornutus*), the little grebe, *P. minor* (*pl.* 91, *fig.* 2), and several other species are found in both Europe and America. A very curious bird of this group is the sun bird or sun grebe of South America, *Heliornis surinamensis* (*pl.* 94, *fig.* 12). It is chiefly seen on the banks of rivers and creeks, and possesses considerable beauty of plumage.

Fam. 3. Alcidæ. Contains the auks, guillemots, penguins, and some other similar birds, the greater part of which inhabit the polar circles.

Sub-fam. 1. *Alcinæ, or Auks.* Bill rather short, much compressed, tip of upper mandible hooked and acute; wings long and perfectly formed; tail short; tarsi short, compressed; toes webbed. Size various.

These birds are very abundant in northern latitudes, but appear only occasionally in more temperate regions. They live chiefly in the water, but are capable of flying (which is not the case with some birds of this family). The great or king auk (*Alca impennis*) is the largest species, the razor-billed auk, *A. torda* (*pl.* 91, *fig.* 15), and the puffin, *Fratercula arctica* (*pl.* 91, *fig.* 14), are other well known species.

The little auks of the genus *Phaleris* are arranged here. They inhabit exclusively the northern regions, and partake of the general characters of the other birds of this group.

Sub-fam. 2. *Spheniscinæ, or Penguins.* Bill rather long, straight, compressed; wings very short or rudimental, and covered with scale-like feathers; tail short, stiff; tarsi very short; toes moderate. Size generally rather large.

The penguins, of which about twenty species are known, are found in the Southern Ocean, having been observed in the highest southern latitudes yet visited by voyagers, though some species inhabit the islands of the extreme south of both continents. They are mostly seen in small parties in the open sea, or standing upright on the floating fields of ice; but, as the breeding season advances, they approach the islands in immense flocks. Their power of swimming is extraordinary; and, assisted by their fin-like wings, they dart with great swiftness through the most stormy sea. These birds have been observed swimming in the ocean at a distance of three hundred miles from land. The crested penguin, *Eudytes cristatus* (*pl.* 92, *fig.* 2), the Patagonian penguin, *Aptenodytes patagonica* (*pl.* 91, *fig.* 13), and other species, are frequently seen in collections.

Sub-fam. 3. *Urinæ, or Guillemots.* Bill rather long, slender, and strong; wings and tail short; tarsi short and compressed; toes moderate. Size small.

A group of birds almost entirely confined to the northern regions, whence they occasionally migrate into more temperate latitudes. The little guillemot (*Mergulus alle*), the black-throated guillemot (*Uria antiqua*), the foolish guillemot (*U. troile*), the black guillemot (*U. grylle*), and about ten other species are known.

Fam. 4. Procellaridæ. Embraces the albatrosses and petrels, birds of great power of flight, inhabiting the sea-shores of the whole world, but most abundant in southern latitudes.

Sub-fam. 1. *Diomedeinæ, or Albatrosses.* Bill long, robust, curved at the tip; wings very long, narrow; tail short, rounded; tarsi short, robust; feet large. Size large.

These, which are the largest of sea-birds, inhabit both hemispheres, but are most abundant in the Southern Ocean. They are sometimes seen at great distances from the land, and are capable of long-continued and vigorous flight. The great white albatross, *Diomedia exulans* (*pl.* 91, *fig.* 12), the green-billed albatross (*D. chlororhyncha*), the sooty albatross (*D. fuliginosa*), are the principal known species.

Sub-fam. 2. *Procellarinæ, or Petrels.* Bill rather short, slender, compressed, tip hooked; wings long, pointed; tail moderate, sometimes forked; tarsi generally long, slender; feet moderate, fully webbed. Size small.

A group of about sixty birds, mostly of small size, known to seamen by the names of sea-pigeons, petrels, Mother Carey's chickens, &c., inhabiting the seas of the whole world. During heavy gales, some of the species are most active, and appear to walk, with their wings expanded, on the tops of the waves. They feed on small marine animals and sea-weeds, and will

follow ships for immense distances, for the purpose of picking up such articles suitable for their food as may be thrown overboard. The cape pigeon, *Procellaria capensis* (*pl.* 91, *fig.* 11), and the stormy petrel (*Thalassidroma pelagica*), are common species.

Fam. 5. Laridæ. This extensive family embraces all the common and generally handsome sea-birds known by the names of gulls and terns. They are natives of the sea-shores of all countries.

Sub-fam. 1. *Larinæ, or Gulls.* Bill rather long, straight, curved at the tip, which is acute; wings long, pointed; tail moderate; tarsi short, strong; feet moderate, fully webbed. Size various; colors mostly white, and light cinereous.

Nearly fifty species of these birds are scattered over the marine portions of the world, sometimes, during winter, being found in the marshes or on the borders of rivers, but returning to the sea coast during summer. They are generally gracefully formed birds, with pure white or cinereous plumage. The black-headed gull (*Larus atricilla*), the kittiwake (*L. rissa*), the ivory gull, *L. eburneus* (*pl.* 91, *fig.* 5), a beautiful pure white species, the burgomaster (*L. glaucus*), the black-backed gull or saddle-back (*L. marinus*), and the herring gull, *L. argentatus* (*pl.* 92, *fig.* 11), are the principal species of the American sea-coasts, and are also found on those of Europe.

Sub-fam. 2. *Sterninæ, or Terns.* Bill rather long, slender, straight, sharp; wings very long, pointed; tail long, generally forked; tarsi and feet short; Size various; color mostly white.

These handsome birds, known on the Atlantic coasts of the United States by the name of sea-swallows, frequent all the sea-coasts of the world. They are continually on the wing, and their flight is frequently elevated, but at other times near the surface, and of long continuance. When seeking their food, which consists of small marine animals, they generally perform large circles, and, upon discerning a suitable object, suddenly dart upon it. At other times they sweep over the surface of the water in the manner of swallows, seizing with their bills any floating objects. The great sea swallow, *Sterna hirundo* (*pl.* 92, *fig.* 12), the little tern (*S. minuta*), and the sooty tern, *S. nigra* (*pl.* 91, *fig.* 4), are common species.

There are nearly one hundred species of terns.

Fam. 6. Pelecanidæ. Contains the pelicans, cormorants, tropic birds, and some others. They are generally large and powerful birds, and inhabit principally the southern hemisphere.

Sub-fam. 1. *Phætoninæ, or Tropic Birds.* Bill rather long, broad at base; wings long, pointed; tail moderate, two middle feathers lengthened; tarsi and feet short. Size rather small; color white.

Four or five species of these birds inhabit the southern seas, and are usually observed at a considerable distance from land, skimming over the surface of the water, seizing such fishes and other marine animals as approach the surface. They are the especial enemies of the flying fish, and are said to rear their young in hollow trees or in the fissures of rocks. The white tropic bird, *Phæton æthereus* (*pl.* 92, *fig.* 4), is a good example of these birds.

Sub-fam. 2. *Plotinæ, or Darters.* Bill long, slender, acute; wings long; tail rather long; tarsi short, very strong; feet large, fully webbed; neck long and slender. Size rather large; color black.

The darters, of which only four species are known, inhabit the southern regions of both continents. In the southern states of the North American confederacy, a species is frequent, and is known by the name of "snake bird," on account of its long, slender neck, and its habit of swimming with its body submerged, the neck and head only being visible, and presenting much the appearance of a serpent. It is a constant resident in Florida, and is the *Plotus anhinga* (*pl.* 92, *fig.* 5). The other species inhabit Africa and Australia.

Sub-fam. 3. *Pelecaninæ, Pelicans and Gannets.* Bill long, rather slender, tip hooked; lower mandible and throat furnished with a pouch, capable of more or less distension; wings long, pointed; tail moderate; tarsi short; toes moderate, rather long, all four of which are united by the web. Size generally large; color mostly white in adults.

The pelicans, which are at once recognised by their large pouches attached to the under mandible, are scattered throughout the world, living indifferently on rivers, lakes, or the sea coast. The principal American species is the large white pelican (*Pelecanus americanus*), of which we beg the liberty of extracting the following account from Audubon.

"As this species is often seen along the sea shores, as well as on fresh water, I will give you a description of its manners there. While on the island of Barataria, in April, 1837, I one afternoon observed a number of white pelicans swimming against the wind and current, with their wings partially extended, and the neck stretched out, the upper mandible alone appearing above the surface, while the lower must have been used as a scoop net, as I saw it raised from time to time, and brought to meet the upper, when the whole bill immediately fell into a perpendicular position, the water was allowed to run out, and being again raised upwards, the fish was swallowed. After thus swimming for about a hundred yards in an extended line, and parallel to each other, they would rise on wing, wheel about, and re-alight at the place where their fishing had commenced, when they would repeat the same actions. I continued watching them more than an hour, concealed among a large quantity of drifted logs, until their fishing was finished, when they all flew off to the lee of another island, no doubt to spend the night there, for these birds are altogether diurnal. When gorged, they retire to the shores, to small islands in bays or rivers, or sit on logs floating in shallow waters at a good distance from the beach, in all which situations they are prone to lie down or stand closely together."

This bird is a constant resident in the southern parts of the United States, as is also the brown pelican (*P. fuscus*), a smaller species, but very similar in general history.

The great pelican (*P. onocrotalus*), and the hairy pelican, *P. crispus* (*pl.* 91, *fig.* 6), which are the largest of all species, inhabit the seas of Europe and Asia. Six or eight other species are known.

The frigate pelican, or man-of-war bird, *Tachypetes aquilus* (*pl.* 92, *fig.* 3), is common to both the old and new worlds.

The gannets are also arranged here. These are not so large as the pelicans, though similar in many respects, and are found in immense numbers on desert and rocky islands in various parts of the world. The booby, *Sula bassana* (*pl.* 92, *fig.* 6), and the brown gannet (*S. fusca*), are good examples of these birds, of which there are about a dozen species.

Sub-fam. 4. *Carboninæ, or Cormorants.* Bill straight, slender, hooked at the tip; wings moderate, pointed; tail moderate, rounded; tarsi short, compressed; toes long, all four united by the web of the feet. Size rather large; color mostly black.

The cormorants have been proverbial for their voracity from time immemorial, and may be termed the vultures of the sea. They are found in small parties on all sea coasts, and are very successful fishers, being capable of diving and swimming under the water with great velocity. In this manner they capture their prey, which consists principally of fishes, and which, it is said, are caught carefully by the head, so that the scales and fins may not impede their being swallowed.

There are about thirty species of cormorants, of which the common cormorant, *Carbo cormoranus* (*pl.* 92, *fig.* 1), the crested cormorant (*C. dilophus*), the violet cormorant (*C. violaceus*), are the most common American species; the first of which is also common on the sea shores of Europe.

With this sub-family we complete the Class of Birds.

VERTEBRATA.

Class IV. Mammalia (Mammals).

The class of Mammalia, it is well known, stands at the head of the vertebrated animals; the decided superiority of its organization, the multiplicity of its aptitudes, sensations, and motions, which other classes do not possess, entitle us to consider it a step in the ascending scale of beings, and indeed the last of the animal creation.

The mammals are vertebrates whose body is covered with hairs, or modified hairs, by opposition to the feathers of birds and scales of reptiles and fishes; possessing, like birds, warm and red blood; a heart with two ventricles and two auricles, and breathing by lungs. Mammals, instead of laying eggs like other vertebrates, bring forth living young, which are nourished by mammæ situated on the inferior surface of the female, sometimes on the breast and sometimes on the abdomen.

The skin of the mammals is more or less thick, sometimes transformed into a cuirass, as in the *tatous*, or else the upper part of the body is covered by imbricated scales, as in the *pangolins*. Generally its exterior surface is covered with hairs, which sometimes appear under the form of spines, bristles, or wool. The ordinary hairs are smooth, in most cases directed backwards. When the hairs on the nape and neck are very long, they form a mane; on the lips and cheeks, or on the chin, they constitute a beard; above, on the top of the head, a tuft, or wig; and on the extremity of the tail, a tuft again.

Sometimes, as in the horse, the tail is furnished with long depending hairs hanging down from its very base; at other times, long hairs hang down from each side of the tail. In several mammals, as, for example, squirrels, the long hairs on the head are directed towards both sides, right and left. Some, again, as the lynx and squirrel, have a long bush of hairs at the end of each ear. There are also mammals whose whole body is covered with long hairs. The hairs are called wool when they are fine, soft, and curled or crisped. In some, as the sheep, the body is only covered with wool, but in many mammals the wool is found between the smooth hairs, and covered by the latter, which extend beyond it. This is the under-wool analogous to the down in birds. Bristles are the stiff, stout hairs; in the hog, for instance, the whole body is covered with them; in other animals they are limited to the angle of the mouth, or behind it, where they are very long, and are then called moustaches or whiskers. When the hairs are very thick, acute at the extremities, and horny, they are called spines, as in the urchin or hedgehog, and porcupine. In some mammals we find the posterior part of the body, or a part of the breast, the knees and the sole of the feet, deprived of hair. Usually in such cases the skin is harder in those parts than where it is covered with hairs. These bald

places are called callosities. The end of the snout and the under surface of the toes want the hair in most of the mammals. The *Cetacea* have no hairs at all, and the *Sirenidæ* only at the margin of the snout and eyelids.

Often the color changes according to the age, the climate, the locality, and the season of the year. In domesticated animals the color of the hair undergoes quite as many variations, and becomes also often longer or shorter, or it crisps like wool, although the hair may have been straight in the original stock of their race. Many mammals are provided with appendages on their forehead, which may be presented under three types: horns, as in sheep and oxen; antlers, as in deer; and agglutinated hairs, as in the giraffe and rhinoceros. Horns proper are so placed as to cover a horn core, a projection of the frontal bone. They increase in size every year, without being ever shed, and usually occur in both sexes. They are found in oxen, sheep, goats, antelopes, chamois, &c.

The horns of deer are more properly termed antlers, in French called *bois*, or wood. These are entirely solid, and are shed every year, to give place to a larger pair. The female rarely possesses them; an exception is, however, found in the reindeer. The annual shedding and growth of the horns is very curious and interesting. We take the example of the deer, according to Bell's History of British Quadrupeds. "Let it be stated first that the horn is placed upon a protuberance on each side of the frontal bone: the part which rests upon the bone, forming the base of the horn, is surrounded by a rough protuberant ring called the *burr*. Now the principal stem of the horn has the name of the *beam;* the irregular divisions near its extremity are termed *branches*, and are distinguished from the true antlers, which are the essential branches belonging to the species, and stand generally forwards, of which the first is called the *brow-antler*, the next the *bez-antler*, and the third the *royal;* the crown is termed the *surroyal*. By the number of these antlers, and other marks in the development of the horns, the age of the animal may be nearly ascertained. The growth of the horns is an astonishing instance of the rapidity of the production of bone under particular circumstances, and is certainly unparalleled in its extent in so short a period of time. A full grown stag's horn probably weighs twenty-four pounds, and the whole of this immense mass of true bone is produced in about ten weeks. During its growth, the branches of the external carotid arteries, which perform the office of secreting this new bone, are considerably enlarged, for the purpose of conveying so large a supply of blood as is necessary for this rapid formation. These vessels extend over the whole surface of the horn as it grows, and the horn itself is at first soft and extremely vascular, so that a slight injury, and even merely pricking it, produces a flood of blood from the wound. It is also protected at this time with a soft hairy or downy coat, which is termed the velvet; and hence the horns are said to be in the velvet during their growth. When completed, the substance of the horns becomes dense, the arteries become obliterated, and the velvet dries and falls off in shreds, a process which is hastened by the animal rubbing his horns against the branches of a tree. The horns remain solid and hard, constituting the most effectual weapons

of defence; and they are often used during the pairing season in violent and sometimes fatal combats between the males. After this season is over, absorption takes place at the point where the horn joins the boss or frontal process, and at length falls off, to be renewed again in due time. Such is this remarkable process in deer generally; the period at which it takes place varies according to the species."

Several mammals have on their faces membranous appendages, or else prominent folds of the skin, as, for example, on the nose of some bats. The lips in mammals are generally fleshy, the upper one sometimes fissured, and in a few cases even entirely wanting. The tongue, fleshy and movable, is connected with a bone called the hyoid, which is composed of several pieces, and suspended to the cranium by ligaments. The upper surface of the tongue possesses small warts or papillæ, which are generally blunt and soft, but in some genera are acute and more or less hardened. The nerves of taste extend to these papillæ, whence the name of nervous papillæ given to the latter. In some mammals the tongue is vermiform, long, and protractile; in the leaf-nosed bat (*Vampyrus phyllostoma*) it is tubular, folded together, and also provided at its extremity with projecting papillæ. The giraffe can protrude the tongue considerably, and by this means take hold of surrounding objects.

In some mammals the nose grows into a proboscis; in others, on the contrary, it is very little or not at all apparent. Many kinds which live in water can shut the nostrils, or openings of the nose, when diving. The nostrils in the whale are on the top of the head, and in some of them they open exteriorly by a single opening. The sense of smell is more or less developed in mammals.

The eyes, invariably lodged in an orbit, are protected by two or three lids. They are of different sizes; in some very small, even hidden under the epidermis, as, for instance, the blind mouse (*Spalax typhlus*). The pupil is generally circular; but in some animals, as in cats, foxes, &c., it is elongated vertically, while in others the elongation is horizontal. The eyes are furnished with eye-lashes. Many ruminants have a lachrymal opening at the inner angle of the eye; at least, there exists a cavity which secretes a fatty and black (often hardened) substance.

The size of the ear-opening, as well as that of the concha itself, is very variable; the latter sometimes is entirely wanting; where it exists, it is either erect, or hangs partially or completely down; the animal can also direct it more or less towards the place whence a sound comes. Most of the bats have before the ear an erect membrane, which is called ear-cover (*antitragus*), serving in a measure to this purpose. The seals have a similar adaptation, although less conspicuous. The ears of many other mammals can also be shut. The bats appear to possess a very delicate sensibility in the membrane of the ear, which is furnished with an abundance of nerves, as well as in the membrane of the wings.

In most of the mammals the snout and toes perform the functions of prehensory organs; in the proboscidians, it is the proboscis. The snout, in some cases, is provided with peculiar papillæ-like projections: this is seen in the mole; the finger-like, elongated appendages of the proboscis of the

elephant; and of the upper, prehensile lip of the rhinoceros. The upper jaw is always immovable, and united to the skull, whilst the lower moves vertically against it, the latter always possessing two simple articulations placed at right angles in the higher groups.

The teeth, which are wanting in some few, vary very much in their number and their shape, and when they exist they are confined to the jaws upon which they rest, implanted into alveolæ. They are of four kinds, *incisors, canines, molars,* and *premolars,* which sometimes exist together, whilst sometimes only two kinds, or even only one is met with. Their relative position is invariable and well known, and their form very characteristic. The incisors are generally chisel shaped, sharp, and straight, seldom curved, and always prominent among the others, occurring in variable number, and inserted above in the premaxillary, and below on the symphyses of the lower jaw; in some genera, completely wanting. The canines, still oftener absent, are acute, with a conical crown and a single root, more or less curved, one in each half of the jaw, behind the incisors; they are often much larger than the other teeth; sometimes, however, shorter, as for example in the shrews. The molars and premolars vary greatly, according to the nature of the food. In the *Carnivora* proper they have a compressed and cutting crown; they are compressed, again, but tuberculous, in the beasts of prey feeding also upon vegetable matter; finally, they are sometimes flat, but usually furnished with enamelled ridges in all those mammals which feed chiefly upon plants or vegetable substances. They are generally provided with several roots. In the whales, the teeth in the upper jaw are replaced by the whalebones, which are elongated, falcate, elastic, and flexible plates, their points directed downwards, provided at their inner extremities with innumerable elongated and loose threads of the same substance as the whalebone itself. *Ornithorhynchus* instead of teeth has a pair of horny tubercles, and *Echidna* is provided on the palate with several rows of spines directed backwards.

Every bone composing the skull is united to its neighbor by intimate suture, and sooner or later is soldered to it, so as to form a continuous cavity for the brain. The skull articulates to the vertebral column, by means of two condyles, with the atlas or first vertebra of the neck. The articulation takes place below the great posterior opening through which the brain passes into the spinal canal. The lateral motion of the head does not take place upon the first vertebra, being performed by the first vertebra upon the second. The neck, whatever be its length, consists of seven vertebræ. In the supposed exception, the sloth, which appears to have nine, we find, on careful examination, that the two last are really the two anterior dorsal vertebræ, as shown by the presence of floating ribs. They are distinguished by the small development of the lateral apophysis. The vertebræ of the back, to which ribs are always attached, vary greatly in number, but are always more numerous than the abdominal ones; their body is stouter than that of the neck vertebræ, and they diminish in size backwards. The abdominal vertebræ, on the contrary, increase in size backwards; they are easily distinguished from the vertebræ of the back by the absence of articu-

lating surfaces, there being no ribs connecting with them. The vertebræ which follow the abdominal ones are soldered together, and constitute the quadrangular *ossa sacra*, or *sacrum*, concave below and convex above. Their number is generally very restricted, and varies within narrow limits. The vertebral column terminates by the vertebræ of the tail, which in their form and number differ greatly from the others. The first ones still possess the canal for the spinal marrow, but it vanishes gradually; and the last of the series consists of a cylindrical or prismatical body, more or less elongated, with rudimentary apophyses, or completely deprived of them.

The ribs correspond in number to the dorsal vertebræ; they are elongated and curved cylindrical, prismatical, or compressed bones, without lateral processes, and never immediately connected with the breast bone below. The breast bone itself is composed of numerous cylindrical or compressed pieces, situated behind each other, with which the true ribs are united by means of cartilages. The others, or false ribs, are situated behind the breast bone; are always shorter, and are connected together by cartilaginous pieces.

Most of the mammals are provided with four legs; the hind pair consisting of a thigh, a shank, a tarsus, and a foot; the fore pair, of an arm, a fore arm, a wrist, and a hand. The fore legs are generally shorter than the hind ones, and usually bent a little inwards; but, again, in some they are so short, and the hind so long, that when the animal attempts to walk on four legs, the anterior part of the body is much lower than the posterior part, even though the hind legs be considerably bent. Hence, it results that these animals, as kangaroos, &c., prefer jumping or running on the hind legs alone. The opposite development of the legs, or the presence of fore legs longer than the hinder, is observed in the Asiatic orang outang, in the long-armed monkey, the sloth, &c. In the bat, also, the fore legs, or rather the fingers, are very long, and between them and the hind legs the skin of the body is extended, so that by this means these animals can keep on the wing. In others the skin is less expanded, and serves only as a parachute, and not for the real act of flying. Mammals walk either on the toes alone, or else, as in the bear, on the entire sole of the foot. In the first case, the foot is generally long, and forms, with the lower end of the leg, the backward directed knee.

The feet are usually directed forwards; only in the walrus and seal, and slightly in the bat, the hind feet are directed backwards. Some are provided with short and broad fore feet, fitted for digging or scratching in the sand.

The normal number of toes is five, viz. the thumb, the innermost toe; next to this, the indicator-finger; then the middle finger; next to the latter, the ring-finger; and finally the outermost, the little finger. But in several genera there is one finger wanting to the hind feet; or two are wanting; or we find four toes to the fore feet, and five behind; or four everywhere; or four to the fore, and three to the hind feet; or two before, and four behind; or two before, and three behind. These toes, however, are not always developed; as, for instance, in the case of a single hoof, or of two hoofs.

In others, again, they assume diverse degrees of development, more or less elongated, as, for instance, in those which are used for clasping or seizing. They are longer and thinner when destined only to walk or to dig. In some mammals, the thumb is opposed to the other fingers or toes, so that it works with the latter as a pincer. In this case, the feet are called hands. The use of the thumb is sometimes also very much reduced.

Generally, the extremities of the toes terminate by horny bodies, which are called hoofs, when they surround all the toes at once; nails, when they present themselves as mere plates on the upper surface and extremity of the toes; and finally claws, when they are compressed, pointed, curved, seldom straight, and inserted above at the extremity of the toes. When the claws approach nearer to the nature of the hoof, they are then called hoof-nails. Sloths and ant-eaters, when at rest, can bend backwards their long claws under the sole of the foot, whilst most of the cats and carnivora retract them into a fold of the skin. The two-hoofed mammals, and the hogs and the allied genera, besides the developed toes which are surrounded by the hoof, have usually two small rudimentary ones, provided with hoofs, which are called posterior hoofs, placed above and posterior to the true hoofs. The males of *Ornithorhynchus* and of *Echidna* possess, on the heels of the hind feet, a horny spur. The horny envelope sometimes is wanting to many toes, and this is especially the case for the thumb of a few genera. Sometimes, also, the toes are partly or entirely soldered together, or they are united into a membrane fitted for swimming. This membrane sometimes extends beyond the tips of the toes, and sometimes reaches only half their length (semi-palmated feet). The fore feet of *Cetacea* are in a very rudimentary state, and the hind feet are completely wanting.

For their protection and their defence, the mammals are provided with teeth, claws, or hoofs, and with antlers or horns. The elephant defends itself not only by means of the tusks, but also with its proboscis; the skunk discharges at its enemy a fetid fluid, secreted by special anal glands; others attempt to escape by flight, or by feigned death; still others have spines, scales, or bony cuirasses, as means of defence. The quadrumana, or monkeys, make use of surrounding objects, as stones and sticks, to keep off their enemies.

The male lives either with one female alone or with several. The female brings forth young either once only or several times a year; and in the colder regions, this takes place during the warmest season. The female of most genera prepares for its young a soft bed; those only whose young can see and walk, or swim, immediately after birth, as is the case with the hoofed mammals, the seals and cetacea, &c., do not provide such a litter, nor do those which carry about their young. The young of other mammals are very weak when just born, and are often unable to see before nine or fourteen days. The number of young at a birth varies; usually less as the animal is greater. The hog, however, constitutes an exception. Dogs, foxes, and cats bring forth three to six at a birth. The young are first suckled by the mother, and as long as she feeds them she displays towards them the warmest affection, exposing herself to every danger in protecting

them. In the case of mammals living in pairs, as in *Carnivora*, the male usually takes his part in this safeguard.

All mammals have a voice, which is very diversified, although not so much so as in birds.

Among all classes of animals, that of mammals is undoubtedly the one which is the most profitable to man, especially the domesticated kinds. Their flesh serves as food, as also the milk. The skin, fur, hair, and wool have a thousand applications. Several animal substances are used as medicines, and others as perfumery, still others as fuel (as for instance, the excrements of the camel); teeth, bones, hairs, horns, antlers, entrails, skin, muscle, tendons, as also blood and fat, are worked up and made use of in various ways. Finally, many serve us as guides in hunting, as beasts of burden, or as vigilant guards of life and property.

The class of mammalia exhibits the greatest variety of habits among its members. Created to inhabit chiefly dry land, it is met with in every situation and locality, from the edge of the water to the top of the mountains, from the surface of the ground and under it to the top of the trees, in forests, open land, dry and wet, everywhere, exposed to the bright sun of the equator and to the frozen regions of the poles. Some frequent watery places, the banks of rivers, lakes, the beaches and sea shores Still others, entirely pelagic, are never seen near the land, except when thrown ashore by storms or other accidental causes. Again, in relation with all these circumstances of habitation, there are habits and instincts by which each species secures its food, escapes the dangers of its enemies or attacks a defenceless prey, and provides for the perpetuity of its race.

Classification.

Of the numerous systems of classification of mammals hitherto proposed, no one appears satisfactory to us. From the time that whales and dolphins (*Cetacea*) were acknowledged to be mammals, they have been considered as the lowest of all, on account of their inhabiting the water, and the analogy of their form with that of fishes. In all systems of classification they are placed lowest. This position is assigned them in the Systema Naturæ of the great Linnæus. In Cuvier's Animal Kingdom, the *Cetacea*, as usual, are placed at the bottom of the class, the *Ruminantia* come next, then *Pachydermata*, then *Edentata*, then *Rodentia*, then *Marsupialia*, then *Carnivora*, *Insectivora*, *Cheiroptera*, and, finally, *Quadrumana*. Others make Pachydermata follow the Cetacea and precede Ruminantia, which appears to us much more correct. But the place assigned to Edentata and Marsupialia, we believe, is arbitrary, for, as they stand, they rather obscure than enlighten the affinities of the neighboring orders.

During the last ten years, a modification has been introduced into our systems, which consists of dividing the class into two sub-classes, namely, the *Monodelphes*, including the generality of mammals whose young, when just born, require no other care from their parent except to suckle them;

and the *Didelphes*, much less numerous, whose young come into the world at an epoch when they are not yet fully developed, and for that reason require more special and extraordinary care from the female, who is furnished with an abdominal pouch, where the young are sheltered, and at first permanently attached to the teat. The Didelphes have besides, two additional bones to their skeleton, called the marsupial bones.

This was a decided improvement, but the Edentata still remain isolated or scattered, without permanent place.

This fundamental division into two parallel groups corresponds exactly to another, based upon the presence or absence of a placenta, that part of the fœtal envelopes which unites the young more intimately with the mother, and by means of which they are supplied with blood. The Monodelphes are called *Placentalia*, whilst the Didelphes are *Aplacentalia*, or deprived of this organic connexion. Such a division may appear natural at first sight, as it seems to express some embryonic law. But embryology has not yet done all that we may expect from it with regard to our classification. It will furnish us one day with data by which the natural affinities and mutual relationships of the fundamental, and also minor groups, shall be unfolded. The embryology of mammals is still in its infancy, especially in that part of the genesis which relates to the earliest phenomena which take place immediately after the fecundation of the eggs.

The disposition of the minor groups in the systems just alluded to varies among the various authors, showing how far this class is from being understood. Thus the following arrangement was published in France in 1845.

Sub-Class I. Placentalia.

Order I. Primates : *Families*, Simiadæ, Lemuridæ, Tarsidæ, Chiromyidæ.

Order II. Tardigrada : *Fam.*, Bradipodidæ.

Order III. Cheiroptera : *Fam.*, Galeopithecidæ, Pteropodidæ, Vespertilionidæ, Noctilionidæ, Vampyridæ, Desmodidæ.

Order IV. Carnivora : *A. Carnivora proper ; Fam.*, Cercoleptidæ, Viverridæ. *B. Amphibia ; Fam.*, Phocidæ, Trichechidæ. *C. Insectivora ; Fam.*, Eupleridæ, Tupaiadæ, Gymnuridæ, Macroscelidæ, Soricidæ, Talpidæ, Erinaceidæ.

Order V. Rodentia : *Fam.*, Sciuridæ, Muridæ, Pseudostomidæ, Spalacidæ, Hystricidæ, Leporidæ, Cavidæ.

Order VI. Pachydermata : *Fam.*, Hyracidæ, Elephantidæ, Tapiridæ, Rhinocerotidæ, Hippopotamidæ, Suidæ, Equidæ.

Order VII. Ruminantia : *Fam.*, Camelidæ, Antilopidæ.

Order VIII. Edentata : *Fam.*, Dasypodidæ, Myrmecophagidæ, Manidæ.

Order IX. Sirenidia : *Fam.*, Manatidæ, Halicoridæ, Rytinidæ.

Order X. Cetacea : *Fam.*, Delphinidæ, Physeteridæ, Balænidæ.

SUB-CLASS II. APLACENTALIA.

ORDER I. MARSUPIALIA CARNARIA: *Fam.*, Dasyuridæ, Didelphidæ, Peramelidæ, Myrmecobidæ, Tarsipedidæ.

ORDER II. MARSUPIALIA FRUGIVORA: *Fam.*, Phalangidæ, Phascolarctidæ, Macropodidæ, Phascolomydæ.

ORDER III. MONOTREMATA: *Fam.*, Ornithorhynchidæ, Echidnidæ.

In 1846, Ch. L. Bonaparte gave to the scientific world the following system.

SUB-CLASS I. PLACENTALIA.

Series.	*Section.*	*Order.*	*Family.*
I. Educabilia.	I. Unguiculata.	1. Primates.	Hominidæ, Simidæ, Cebidæ, Lemuridæ, Galeopithecidæ, Chiromidæ.
		2. Feræ.	Cercoleptidæ, Canidæ, Viverridæ, Felidæ, Mustelidæ, Procyonidæ, Ursidæ.
	II. Pinnata.	3. Pinnipedia.	Phocidæ, Trichechidæ, Hydrarchidæ.
		4. Cete.	Delphinidæ, Physeteridæ, Balænidæ.
		5. Sirenidia.	Manatidæ, Dinotheridæ.
	III. Ungulata.	6. Belluæ.	Elephantidæ, Rhinocerotidæ, Hyracidæ, Suidæ, Hippopotamidæ, Anoplotheridæ, Equidæ.
		7. Pecora.	Camelidæ, Cervidæ, Camelopardalidæ, Bovidæ.
II. Ineducabilia.		8. Bruta.	Manidæ, Myrmecophagidæ, Orycteropodidæ, Dasypodidæ, Megatheridæ, Bradipodidæ.
		9. Cheiroptera.	Pteropodidæ, Vespertilionidæ, Vampyridæ.
		10. Bestiæ.	Talpidæ, Soricidæ, Erinaceidæ.
		11. Glires.	Sciuridæ, Muridæ, Castoridæ, Bathyergidæ, Hystricidæ, Echimyidæ, Dasyproctidæ, Octodontidæ, Lagostomyidæ, Cavidæ, Leporidæ.

Sub-Class II. Ovovivipara.

Order 12. Marsupialia: *Families;* Thylacinidæ, Dasyuridæ, Didelphidæ, Peramelidæ, Phalangistidæ, Halmaturidæ, Phascolomyidæ.

Order 13. Monotremata: *Fam.*, Echidnidæ, Ornithorhynchidæ.

The above systematic arrangement does not appear satisfactory to us, and we therefore substitute the one which follows, although well aware that it is far from being perfect. It will no doubt undergo some changes in the relative position of the minor groups; but so far as our great groups follow each other, we are confident that they express more exactly the development of the mammalian structure.

Class Mammalia.

I. Quadrumana.
Simiadæ, Cebidæ, Lemuridæ, Galeopithecidæ, Chiromyidæ.

II. Carnivora.
a. Unguiculata.
1. *Digitigrada.*
Felidæ, Hyænidæ, Canidæ, Viverridæ, Mustelidæ.
2. *Plantigrada.*
Cercoleptidæ, Procyonidæ, Ursidæ.
b. Pinnipedia.
Phocidæ.

III. Cheiroptera.
a. Frugivora.
Pteropodidæ.
b. Carnivora.
Vespertilionidæ, Vampyridæ.

IV. Insectivora.
Erinaceidæ, Soricidæ, Talpidæ.

V. Herbivora.
a. Rodentia.
Sciuridæ, Castoridæ, Muridæ (including Myoxina, Dipodina, Ctenodactylina, Murina, Spalacina, Arvicolina, Bathyergina, Saccomyina), Hystricidæ (including Hystricina, Dasyproctina, Echimyina, Octodontina, Chinchillina, Caviina), and Leporidæ.
b. Ruminantia.
Bovidæ, Antilopidæ, Cervidæ, Moschidæ, Camelopardalidæ, Camelidæ.
c. Pachydermata.
Equidæ, Suidæ, Hyracidæ, Elephantidæ, Palæotheridæ, Rhinocerotidæ, Hippopotamidæ, Anoplotheridæ.

d. *Trichechidæ.*

e. *Sirenidia.*

Rytinidæ, Halichoridæ, Manatidæ, Dinotheridæ.

VI. CETACEA.

Heterodontidæ, Delphinidæ, Physeteridæ, Balænidæ.

VII. MARSUPIALIA.

a. *Carnivora.*

Thylacinidæ, Didelphidæ, Dasyuridæ.

b. *Insectivora.*

Peramelidæ.

c. *Herbivora.*

Phalangistidæ, Phascolomyidæ,Macropodidæ (Halmaturidæ).

VIII. EDENTATA.

a. *Tardigrada.*

Bradipodidæ, Megatheridæ.

b. *Edentata proper.*

Manidæ, Myrmecophagidæ, Orycteropodidæ, Dasypodidæ.

c. *Monotremata.*

Echidnidæ, Ornithorhynchidæ.

A glance at the actual and terrestrial mammalian fauna of North America shows a scarcity of the types which we have placed at the bottom of the class: the two great groups of EDENTATA and MARSUPIALIA have each but one species, both confined to the warmer part of the continent. The *Pachydermata* are represented by a single species also, not taking into consideration the introduced species, the horse, the ass, and hog. The *Ruminantia* are distributed into eight genera, seven of which comprise but one species, the introduced not included. The *Rodentia* are the most numerous: they form twenty-one or twenty-two genera, and count from eighty to ninety species; the rodents, it must be observed, are among the smallest mammals, and therefore strike the attention less than either the ruminants or pachyderms. INSECTIVORA, twenty to twenty-five in number, are arranged into six genera. The CARNIVORA, the number of which is a little above thirty, are distributed into fourteen genera, several of which have only one species. The viverrine carnivora are almost completely absent. If future investigations shall increase the number of North American mammals, it cannot be but in favor of the rodents mostly: that group, therefore, may be considered as the most numerous in North America; next the carnivora proper; next the insectivora, then ruminants. The reasons for such proportions must be sought for in the physical condition of the continent: the small number of grass feeders is a very remarkable fact, and doubtless in direct relation with the proportion of carnivora. Thus America, although the *continent of vegetation,* has not received a proportional number of herbivora, showing that the equilibrium between the different orders of animals is more important than that of the vegetable and animal kingdom.

In our narrative of the history of each group we shall start from below and ascend the series which we have just presented, commencing accordingly with Edentata. In a natural method the extinct groups should always precede the living ones; but as they are generally less known, they will be found sometimes to follow the latter, and more specially so when doubts are entertained with regard to the family and genera to which they may belong.

Order I. Edentata.

The order of Edentata is composed of comparatively few animals, differing widely from each other, but agreeing in the common characters of absence of front teeth or incisors, and the presence of feet that are unguiculated, that is to say, terminated by large claws or nails. The Edentata existed in larger proportion during the tertiary epoch than in our days, and from considerations derived from palæontological evidences to be discussed hereafter, we suppose that they have lived during the deposition of the secondary beds, although no remains have yet been found in those deposits. It is also a fact of great importance that during the tertiary period the animals of this order attained to a bulk far surpassing that of any living representatives.

The Edentata may be divided into three groups, according to certain modifications in their organization, the *Monotremata*, the *Edentata proper*, and the *Tardigrada*.

Group 1. *Monotremata.*

The group of *Monotremata* has received its name from the peculiarity of having only one external opening for the seminal fluid, urine, and excrement, as in birds. They possess the marsupial bones, but have no external pouch in which the young pass one part of their embryonic life, as in Marsupialia. The mammæ themselves have been long a matter of doubt, as well as their mode of generation. According to some travellers these animals lay eggs. But if the mammæ do not exhibit a projecting nipple, still the mammary glands have been shown to exist on the abdomen in the form of numerous elongated, sub-cylindrical lobes, converging and opening into a small oval areola. The ear has no external concha. The structure of the skeleton presents many peculiarities by which this family is distinguished from any other. The sternum and shoulder bones join and encircle the fore part of the trunk. Their brain wants the corpus callosum, and the mass called corpora quadrigemina is imperfectly divided.

This group contains but two families, *Ornithorhynchidæ* and *Echidnidæ*, both of them belonging to Australia.

Fam. 1. Ornithorhynchidæ, includes but one genus, *Ornithorhynchus*,

with its bird-like snout, a broad and depressed bill, covered by naked skin. The jaws are furnished on each side and towards the front with a long, narrow, horny appendage, and towards the hinder part with a broad, nearly ovate crushing tooth, of the same material. The tongue is short, and provided in part with horny papillæ. The eye is small. The body depressed, nearly oval, and clothed with a dense fur. The legs are short, and the feet organized for swimming. Each foot is provided with five well developed toes, between which a membrane extends considerably beyond the toes in the forefoot, the claws of which are large, solid, and depressed, and fitted for burrowing. The tail is rather short, broad, and depressed. The male is provided with a spur to the hind foot. The name of Ornithorhynchus has reference to the peculiar structure of the bill. A single species is well determined, namely, *O. anatinus* (*pl.* 112, *fig.* 1), of about eighteen inches in length, the general color dusky brown, on the upper part of the body rather dark, on the under paler. It inhabits New South Wales and Van Diemen's Land, where it is called water mole by the colonists, on account of its aquatic habits and some slight resemblance which it bears to the common mole of Europe. It is very difficult to watch them in their native element, as they remain but a short time on the surface of the water, diving with an extraordinary rapidity at the approach of the slightest danger. The other species described in systematic works are established upon insufficient data, some of them being undoubtedly immature individuals.

Fam. 2. Echidnidæ, containing likewise but one genus, *Echidna*, or porcupine ant-eater, is known by its naked, elongated, slender, and attenuated snout, and the small opening of the mouth. The tongue is protractile, slender, cylindrical, and very long; the palate is furnished with horny papillæ; the teeth are completely wanting. The body is furnished above with spines and hairs intermixed. The legs are short and powerful; the fore and hind feet each with five well developed toes, having large nails; fore feet fitted for burrowing; the hind feet in the male furnished with a spur of a horny substance. The tail is very short. The animals of this genus are found in Australia exclusively. Two species only are enumerated, and one will perhaps prove to be a local variety. At a cursory glance they resemble the hedgehog, were it not for their long and slender snout. *E. aculeata* (*pl.* 112, *fig.* 2) is a small animal, about one foot in length, of a brownish black color. It was originally found at New South Wales, and more recently on the west coast, in Swan river district. *E. setosa* is from Van Diemen's Land, from fourteen to seventeen inches in length.

Both species of Echidna are terrestrial and fossorial; they feed almost exclusively on ants, and play in their zoological district the same part in the economy of nature which is assigned to the pangolins in Asia and Africa, and to the ant-eaters of South America.

Group 2. *Edentata proper.*

This group is characterized by a pointed snout, some of the species still possessing cheek teeth. It may be conveniently divided into four families, the *Manidæ*, the *Myrmecophagidæ*, the *Orycteropodidæ*, and the *Dasypodidæ*.

Fam. 1. Manidæ. A small family very nearly allied to Myrmecophagidæ, differing only from it in having the body covered with scales instead of hairs. The habits are the same; they are ant-eaters, and therefore myrmecophagous. This family is confined to the eastern continent, Asia and Africa, and to it must be referred the only remains of Edentata found in Europe, a fact of no small interest, as respects the geographical distribution of animals.

The genus *Manis*, or pangolins, has an elongated head, a slender snout, with a small mouth, and a long, filiform, protractile tongue; five compressed and slightly curved claws on each foot. The tail is more or less elongated, and protected, as well as the body and head, by tile shaped scales. These animals live in the tropical regions of Africa and southern Asia, where they feed like ant-eaters. In some the tail is longer, and in others shorter than the body; the fore feet are covered exteriorly with scales; the internal nail is nearly equal to the external. Other species have a tail much longer than the body itself, the fore feet hairy, and only covered with scales at their base and exteriorly, but the nails all compressed. *Manis pentadactyla*, three or four feet in length, from East India (*pl.* 112, *fig.* 3), is very abundant at Madras, Pondichery, and Bengal. The long-tailed pangolin (*M. tetradactyla*), of the same size as the preceding, is from Senegal, Guinea, &c. The tail is double the length of the body.

The genus *Macrotherium* lived towards the end of the tertiary epoch, in the centre of the old continent, in France and Germany. The nails are like those of the pangolins, but the teeth most resemble those of the sloths. A single species is known, the *M. giganteum*, the gigantic pangolin.

Fam. 2. Myrmecophagidæ, is characterized by the absence of teeth of any description; the body covered with hairs. This family is restricted to one single genus, comprehending several species, confined to South America. None have hitherto been found in a fossil state, but we may look for some yet unknown genera to fill up the present gaps in the series.

The genus *Myrmecophaga*, or ant-eater, is characterized by a long, thin, and slender muzzle, at the termination of which is a small mouth, provided with a long, filiform, protractile tongue. This they insinuate into ant hills, and the nests of the termites, whence these insects are withdrawn by being entangled in the viscid saliva that covers it. The claws or nails of the fore feet are strong, curved, and compressed, varying according to the species; the body covered with hair; the tail elongated, and prehensile in two of the species. The fore limbs are a little shorter than the hinder, the humerus short and very stout; hind feet smaller and more slender than the

fore. When at rest, as well as during motion, the anterior claws of the large Myrmecophaga are bent against the naked sole, on the outer edge of which the animal walks. All ant-eaters live in the warmest part of South America, west of the Cordilleras, from the Gulf of Mexico to the Rio de la Plata. The great ant-eater, *M. jubata* (*pl.* 112, *fig.* 5), from seven to eight feet long, the tail included, is an inhabitant of the forests, and conceals itself in a hole under the ground, which it leaves during night in search of its food, which consists, as we know, of ants, the small and large termites so abundant in South America. The female brings forth only one young, which is carried about for a time on the mother's back. Another species, *M. didactyla* (*pl.* 112, *fig.* 4), has only two nails to the fore feet, whence its specific appellation. The tail is prehensile. Inhabits the northern part of tropical South America, living chiefly on trees, where it procures its insect food.

FAM. 3. ORYCTEROPODIDÆ, contains as yet but two genera, one now existing, and another extinct.

The genus *Orycteropus*, comprising only one living species (*O. capensis*, the Cape ground hog), inhabits the Cape of Good Hope. The head is similar to that of the ant-eater, and the tongue somewhat extensile, but distinguished from the latter by being furnished with grinders, and by having flat nails, formed for digging, not trenchant. The structure of their teeth differs from that of all other quadrupeds; they are solid cylinders, traversed like reeds, in a longitudinal direction, by numerous little tubes. The body is covered with short hairs of a brownish grey color. The tail is shorter than the body, and covered with equally short hairs. There are four toes to the fore feet and five behind. It inhabits burrows, which it excavates with great facility. There is a fossil species of this order from the Pampas of Brazil, *Glossotherium*, which was established upon a small fragment of bone from the posterior part of the cranium. The size of the holes through which the nerves and blood-vessels for the tongue pass, has induced the supposition that the tongue was very much developed, and that the animal could very likely use it like the ant-eaters. On the other hand, the extent of the temporal muscle and the strength of the zygomatic arch, seemed to show that the animal could grind, and necessarily had molar teeth. For these reasons it has been located in the vicinity of the *Orycteropus* of the present fauna; but more recent investigations have led to the discovery that these remains belonged to *Megatherium*.

FAM. 4. DASYPODIDÆ, is distinguished among Edentata by the scaly and hard shell, formed of divisions resembling little paving stones, which covers the head and body, and frequently the tail. This substance forms one shield over the forehead, a second, very large and convex, over the shoulders, a third on the neck, very similar to the second, and between the two latter, several parallel and movable bands, which allow the body to bend. The tail is sometimes furnished with successive rings, and at others, like the legs, merely with tubercles.

In the genus *Dasypus*, or armadilloes, the ears are very large. There are four, sometimes five, great nails to the fore feet; always five behind. The

molars are cylindrical, seven or eight in number throughout, separated from each other, and without enamel on the inside. The tongue is smooth, and but slightly extensible. Between their scales, or on those parts of the body not covered by the shell, there are few scattered hairs. They dig burrows, and live partly on vegetables and partly on insects and dead bodies. They all belong to the hot, or at least to the temperate parts of America. *Dasypus peba* is found in the southern United States. They may be divided into sub-genera, from considerations drawn from the structure of their fore feet, and the number of their teeth. *Cachicamus* has four toes to the anterior feet, the two middle ones of which are the longest; only seven teeth on each side, and in each jaw. The tail is long, and encircled with bony rings. *Dasypus novemcinctus* (*pl.* 112, *fig.* 8) is the type of this section. *Apara* has the same toes as in Cachicamus, and nine or ten teeth throughout (*D. tricinctus*). *Encoubertus* has five toes to the fore feet, the three middle of which are the longest. The greater part of the tail is covered with scales, arranged in quincunx. There are nine or ten teeth throughout, as in Apara. *D. sexcinctus* (*pl.* 112, *fig.* 7) belongs to this type. *Cabassous* has five toes to the fore feet, but directed obliquely, so that the thumb and index are slender, and the latter the longest; the middle one has an enormous sharp nail: the following one has also a nail, but a shorter one, and the last toe is the shortest of all. This form of the foot enables these animals to divide the earth, and burrow into it with rapidity, or at any rate to cling with such tenacity that it is extremely difficult to tear them from it. They have but eight or nine teeth on each side, and in each jaw. *D. unicinctus* is an example. *Priodon* has the toes more unequal, and the nails larger than in the preceding sub-genera. There are twenty-two to twenty-four small teeth throughout, or ninety-two to ninety-six in all. *D. gigas*, the largest species of the tatous, belongs to this section. It is sometimes more than three feet in length, the tail included.

Several species of the genus *Dasypus* are known in a fossil state, which seem to indicate a wider geographical range, inasmuch as two of them are said to occur in North America, *D. maximus* and *D. antiquus*.

The genus *Chlamydophorus* has the upper part of the body covered with a cuirass composed of rhomboidal plates, truncated behind, only connected to the body along the spine. The rest of the body is hairy. Above and below it is provided with eight cutting teeth. The fingers of the fore feet are inclosed within a membrane, and provided with five strong shovel-like nails. A single species is known, *Chl. truncatus* (*pl.* 112, *fig.* 6), from the interior of Chili, where it passes the most of its time under the ground.

The extinct genera of this family, among which are some gigantic forms, are not without affinities with Bradipodidæ, which they connect more intimately with Dasypodidæ, so distant from each other when the living types alone are taken into consideration. The genus *Glyptodon* has the characteristic descending zygomatic apophysis of the Megatheridæ; but the feet are bulky, and the phalanges, to which nails articulate, are short and depressed. The molars, eight above and eight below, come nearer those

of the tatous by their structure; but the two deep grooves which are seen on their interior surface seem also to indicate a sort of passage to the pachyderms through the genus Toxodon. The cuirass is composed of apparently hexagonal plates, united together by serrated sutures. A single species is known, *G. clavipes*, which reached a very large size; it inhabited the pampas of Buenos Ayres during the pliocene period.

The genus *Hoplophorus* has also the descending apophysis of the zygomatic arch and the heavy forms of Megatheridæ. But the feet are shortened as in Glyptodon, and the molars recall to mind those of some rodents. It was secured with a cuirass composed of hexagonal plates. Several species are found in the Brazilian caverns, two of which, *H. euphractus* and *H. sellowii*, reached the bulk of an ox.

The genus *Pachytherium* is known only by a few bones of the extremities, which indicate still heavier forms. A single species is known, *P. magnum*, from the caverns of Brazil.

The genus *Chlamidotherium* comes very near the tatous. It has the osteology and the cuirass of the encouberts, and the fore feet of the cachicames. There are small incisors analogous to those of the encouberts, and molars which call to mind by their forms those of the sloths and Megatheridæ. Two species were discovered in the caverns of Brazil, *Ch. humboldtii*, of the size of the tapir, and *Ch. gigas*, equalling the largest rhinoceros.

The genus *Euryodon* is characterized by the molars transversely compressed. As yet only a single species, of the size of a small hog, is known. From Brazil.

In the genus *Heterodon* the teeth are more unequal in form as well as in size. The first and the last ones are like thin cylinders. The anterior is oval in transverse section, while in the posterior it is cordiform. The only species known was of the size of a rabbit. From Brazil.

Group 3. *Tardigrada.*

The group of *Tardigrada*, characterized by a short face, is composed of two families, one of them hitherto known only in a fossil state, the *Megatheridæ*, the other only as recent, the Tardigrada proper, or *Bradipodidæ*, or *Gravigrada*.

Fam. 1. Megatheridæ, whose history belongs to the ancient world, resemble Tardigrada proper in having teeth in the shape of hollow cylinders, composed only of ivory and cement, without enamel. The ivory forms a tube filled by a more porous substance. The shape of the head is also very similar; it is short, as if truncated, and the zygomatic bone forms a great descending apophysis, a character found nowhere else in the class of mammalia. The skeletons are very much alike, particularly in the structure of the shoulder, where the acromion and coracoid bones are soldered together. But in the other peculiarities of their structure they come nearer the other families of Edentata. Their general form was bulky, their body heavy,

their feet nearly equal, the anterior possessing four or five fingers, and the posterior three or four; the external fingers were deprived of nails. The tail was very long and powerful.

The genus *Megatherium* is characterized by its teeth, which are tetragonal, and have their crowns transversely furrowed. There are five above and four below on each side. The fibula is soldered to the tibia by both of its extremities. The fore feet have four fingers, the hind feet only three, the two external without nail. Only one species is well known, *M. cuvieri*, from South America. In size this exceeded the rhinoceros. Some fragments of Megatherium have also been found in North America, particularly on the coast of Georgia. The Megatherium is supposed to have fed upon the leaves of trees, previously uprooted by the animal.

The genus *Megalonyx* is distinguished by its molars, five above and four below on each side, sub-elliptical in form, the crown of which is hollowed in the middle, whilst the edge remains prominent. The anterior limbs are a little longer than the posterior ones, a character which brings them nearer the Tardigrada proper than Megatherium. The tibia and fibula are not soldered together; the hind foot is obliquely articulated. The tail is stout and robust. The body of Megalonyx was not so heavy as that of the Megatherium, but the habits were very likely the same. The first species known is *M. jeffersonii*, of the size of an ox. It was found in a cavern in Virginia. A few other species of the same genus have been discovered in South America.

The genus *Mylodon* had the heavy form of Megatherium, but with a quite different dentition. The molars, five above and four below, are worn off in plane surfaces. In the upper jaw, the first tooth is sub-elliptical, the second elliptical, and the others triangular with the internal surface furrowed. In the lower jaw, the first is elliptical, the last but one tetragonal, and the last large and bilobated. The form of the head resembles that of Megatherium. The feet are equal, the anterior with five fingers and the posterior with four; the two external fingers are deprived of nails, the others provided with large phalanges, terminated with semi-conical and unequal nails. Species of this genus are found in South America, as far as the pampas of Brazil (*M. darwinii*), and also in North America, in a cave in Kentucky (*M. harlani*).

The genus *Scelidotherium* is nearly allied to Mylodon. The molar teeth are five above and four below. The upper ones are all triangular. In the lower jaw, the first is triangular too, the second and third a little compressed, and the fourth large and bilobated. The body heavy and bulky. The complete skeleton is not yet known. Four species have already been discovered in South America. The largest, *S. leptocephalon*, was an inhabitant of the southern extremity of the continent. The others belong to Brazil.

The genus *Platyonyx*, with its skull and teeth similar to Bradypus, recalls to mind the armadillo, but resembles Megalonyx by its skeleton. The character by which it is distinguished from all its congeners consists in the high development of its feet. The fore feet, having five depressed

(instead of compressed) claws or nails, could not be used in burrowing, for the articulating surfaces between the tarsus and the first phalanx are flat instead of being rounded, thus excluding at once a vertical motion. They were furnished with longitudinal carinæ, which did not allow of any lateral movement. The habits of Platyonyx were like those of the sloth, probably moving on the earth with more difficulty. Several species are described by Mr. Lund, the size of which varies from that of the ox (*P. cuvieri*) to that of the hog (*P. minutus*).

The genus *Cœlodon* had only four molars above and four below, shortened and unequal fingers, compressed nails, oblique feet, and a tail like that of the Megalonyx. One single species is known, *C. maquinense*, of the size of the tapir, from the caverns of Brazil.

The genus *Sphenodon* had also four molars above and four below, originally conical and becoming cylindrical in being worn off. A single species of the size of the hog was found in the caverns of Brazil.

Fam. 2. Bradypodidæ is represented by a single living genus, *Bradypus*, or sloths. The dentition consists of four cylindrical molars above and three below of the same shape, and with sharp canines longer than the molars themselves. The fingers are united by a membrane, and only marked externally by enormous crooked nails, which, when at rest, are always bent towards the palm of the hand or the sole of the foot. The hind feet are obliquely articulated on the leg, and rest only upon their outer edge; the phalanges of the toes are articulated by a close ginglymus, and the first at a certain age become soldered to the bone of the metacarpus or metatarsus, which also in time present the same feature. To this inconvenience of the organization of the extremities another not less great is added, that is, their proportions. The arm and forearm are much longer than the thigh and leg, so that when these animals walk they are compelled to drag themselves along on their elbows. Their large pelvis and the inclination of their thighs to the sides prevent the approximation of their knees. Their gait is the necessary effect of such a disproportioned structure. They live in trees, and never remove from the one they are on until they have stripped it of every leaf, so painful to them is the requisite exertion to reach another. It is even asserted that, to avoid the trouble of a regular descent, they let themselves fall from the branches. The female produces but a single young at a birth. There are two mammæ on the breast. The sloths possess great muscular power in their fore limbs, which, combined with the stout nails, constitutes an excellent means of defence. This is well known to hunters, who keep their dogs at a certain distance, in fear that they should be killed by them, which is often the case. The species that have three nails on the fore feet and a very short tail have received the sub-generic name of *Achæus*. The aï, of the size of a cat, *Br. tridactylus* (*pl.* 112, *fig.* 10), is an example of this section. Those species which have only two nails to the fore feet and possess no tail at all have been designated by the name of *Cholœpus*, or Bradypus proper, of which the unau, *B. didactylus* (*pl.* 112, *fig.* 9), is the type. It is about one half larger than the aï. The sloths inhabit the warmer portions of South America.

ORDER 2. MARSUPIALIA.

The order of Marsupialia, like that of Edentata, includes animals differing very much from each other, although much more numerous in genera and species. A character common to all Marsupialia consists in the presence of two bones, called *marsupial bones*, attached to the anterior margin of the pelvis. The same bones also exist in the Monotremata of the order Edentata. Another character is that of a pouch situated on the lower part of the abdomen of the female, into which are received the prematurely born young. This generative pouch is not possessed by the Monotremata, although implacental like the Marsupialia. Upon the signification and relative importance of both the marsupial bones and the pouch, we shall have a few words more to say hereafter. The bones of the cranium in Marsupialia do not anchylose, but remain permanently separated. The palatine part of the skull is imperfect, and presents large openings. The angle of the lower jaw is bent inwards, with one single exception, the Tarsipes. The structure of the brain presents also many peculiarities proper to the animals of this order, such as the absence of the *corpus callosum* and the imperfect division of the *corpora quadrigemina*.

To a great diversity in their structure and organization corresponds a no less difference in their habits; some being carnivorous, some insectivorous, and others frugivorous and herbivorous, in different degrees. The kangaroos are more especially grass and herb feeders; the burrowing wombats, root feeders; the phalangers eat the leaves, buds, and fruits of trees.

Among Halmaturidæ, the true kangaroos, we find some species fitted for one region of country, and some for another; some prefer the swamps, and others the high table land. The Dendrolagus and Phalangistidæ inhabit trees, the wombats are subterranean, and the Chironectes aquatic. Of course, we find in several families nocturnal and diurnal genera.

Brazil seems to be the country chiefly adapted by nature to the development of Didelphidæ. From this region they spread north as far as the United States, and south to the great river Plata, diminishing in number as they become more remote from this centre. Peru, Guiana, and Paraguay, the nearest provinces to Brazil, have about half a dozen species.

Five zoological provinces may be established in Australia; an eastern, a western, a northern, and a southern; Van Diemen's Land forms the fifth. The northern province has the greatest number of species peculiar to it, since, out of ten, eight are not found elsewhere. In the eastern province, the species are, for the most part, distinct from those of the opposite side of the continent; out of sixty species, eight are found in both provinces. South Australia, on the contrary, possesses a large proportion of species identical with those of other districts, four species only being peculiar to it. Sixteen species occur in common with western Australia, and fifteen with eastern Australia. The western province has two peculiar genera (*Tarsipes*

and *Macrotis*). About half of the species found in Van Diemen's Land are peculiar to it, the other half are found on the eastern part of the main land.

The species of Marsupialia of the continent of Australia, which are very nearly allied and have very nearly similar habits, are not associated together in the same limited district.

Fossil remains of Marsupialia have been found chiefly in Australia and South America; that is to say, in the same localities inhabited by these animals in our days. Most of them are referable to the same genera. In Europe a species of the genus *Didelphis*, and the new genus *Pterodon*, are from the tertiary beds, and the extinct genera *Amphitherium* and *Phascolotherium*, from the oolite of Stonesfield, the oldest representatives hitherto known of the class of Mammalia.

Group 1. *Herbivora.*

Fam. 1. Macropodidæ. The true herbivorous group of Marsupialia is characterized by six incisors in the upper jaw, and two in the lower; by the absence of canines in most cases (there is sometimes a small one in the upper jaw); by one premolar and four molars, making twenty-eight or thirty teeth. The fore limbs are smaller than the hind, usually much inferior in proportions; the hands naked beneath, and having five well developed fingers; each finger armed with a strong curved claw. The hind legs are large and strong; the foot long, and the toes four in number. The tail is long, and usually very powerful. There are four mammæ. The kangaroos are vegetable feeding animals, browsing upon herbage like the ruminants. Some are of a great size, whilst others are as small as a hare.

This family constitutes the main bulk of the marsupial population of Australia, the only place where remains of extinct species of kangaroos proper have been hitherto found.

Kangaroos use their fore feet less for walking than for gathering their food, which they take sitting erect on the hind legs and tail, in the fashion of the hare and squirrel. They live in small troops, conducted by an old individual, and pass from place to place in the forests and mountains to procure food. If frightened or hunted, they jump and run with great agility and swiftness, sometimes making leaps of from twenty to thirty feet, over ravines, precipices, and bushes. In this their powerful tail is used as well for preserving their equilibrium as for a means of propulsion. The kangaroos defend themselves with courage and skill against their enemies. Many species weigh two hundred pounds when full grown, whilst others only reach a weight of fifty to sixty pounds. All afford a wholesome and agreeable food. There are species of all colors, grey, black, red, &c. The female produces only one young, which is carried about in the pouch, and is the object of constant care until fully grown. Kangaroos, when taken young, are said to have been tamed to such a degree as to make no effort at escape when allowed to run free.

The genus *Macropus* contains upwards of thirty species, and has been subdivided into several divisions, into the details of which we cannot here enter. The great kangaroo (*M. giganteus*) is the type of the genus. It inhabits New South Wales, Southern and Western Australia, and Van Diemen's Land, preferring low grassy hills, and plains, and open parts of the country. In *Macropus*, proper the disproportion between the fore and hind legs is much greater, and the tail more powerful, than in the other section of the genus. The snout is hairy.

The section to which the name of *Onychogalea* has been given, comprises some of the most graceful species of the kangaroo tribe. The size is moderate; the snout is clothed with hair; the fur short.

In the sub-generic section of *Lagorchestis* the snout is clothed with velvet-like hairs; the fore legs are small, and the hand provided with small sharp-pointed nails. They inhabit open plains, and have a general resemblance to the common hare.

In *Halmaturus*, the snout or muzzle is naked in front. This section contains the most numerous species, which are found in districts that are well clothed with shrubs. Two species are represented in our plates, *H. laniger* (*pl.* 112, *fig.* 11, *a b*), and *H. dorsalis* (*pl.* 112, *fig.* 12, *a b*).

Heteropus are kangaroos with a naked snout; the hind foot short and stout, and densely clothed with coarse hairs; nails small; tail cylindrical, and provided with long hairs, especially on the tip. They inhabit rocky situations. Several species of Macropus have been found in a fossil state, all of them confined to Australia. Some had attained a very large size.

The genus *Dendrolagus* includes kangaroos with anterior extremities large and powerful, being but little inferior in size to the posterior ones. The claws of the fore feet are very large, curved, and pointed; the muzzle is clothed with small hairs as far forwards as the anterior angle of the nostrils; the tail is long, cylindrical, and somewhat bushy. Two species of this genus are known, both of which inhabit New Guinea, and are said to ascend the trees, for which habit their strong fore legs, added to the curved and powerful claws, are adapted.

The genus *Hypsiprymnus* has a distinct canine tooth in the upper jaw, and the anterior pair of incisors descends considerably below the level of the two remaining pairs. The rat-kangaroo, or *Potoroo*, as the animals of this genus are called, is of small size, being about equal in bulk to the common rabbit. The form of the body is compact, and the fore parts but little elongated. The small and rounded ears give them a different aspect from the rabbit; the toes of the fore foot are more unevenly developed in the rat-kangaroo; the nails are much compressed, solid, and broadest above. The rat-kangaroos feed upon the roots of plants, which they scratch up with their fore feet. In some species the snout is almost entirely clothed with hairs (*Hypsiprymnus* proper), whilst in others (*Bettongia*) it is naked; and in others again (*Potorous*) the head is elongated, the tarsi short, the tail sparingly clothed with short stiff hairs, and exhibiting a scaly skin; the snout is naked. *Hypsiprymnus* inhabits Australia and Van Diemen's Land.

The two extinct genera which follow partake to a certain extent of the

character of the kangaroo group which precedes, and of the wombat which follows. For a graphic representation of their affinities they should, therefore, be placed at the bottom of these two families, since they have preceded both in the biological history of our planet.

The genus *Diprotodon*, which contains but one species (*D. australis*), we are told must have attained a bulk superior to that of the rhinoceros. The lower jaw was provided with one incisor tooth and five molars, in each ramus. The size of this incisor was very great; it is very long, deeply implanted in the jaw, and nearly approaches a horizontal position, the extremity alone being slightly curved upwards. From La Condamine river.

The genus *Nototherium* reached the same size and bulk as the preceding, that is to say, to something like that of the rhinoceros. Two species are known, both of them from the deposits near La Condamine river. There are no lower incisor tusks, and apparently four molar rooted teeth.

Fam. 2. Phascolomyidæ, differs from the following by having rootless teeth, and also by the reduced number of incisors in the upper jaw. The whole number of teeth is twenty-four, sixteen molars, four pre-molars, and four incisors, two above and two below. The toes of the fore feet have short, broad, and solid nails, fitted for burrowing.

The sole genus, *Phascolomys*, has a stout body, a large head flattened above, the muzzle obtuse; contains but two recent species, *P. wombat* and *P. latifrons*, inhabiting Australia, Van Diemen's Land, and some of the islands of Bass's Straits; naked, the eyes small, the ears small and pointed, the limbs equal, short, and stout. A third species, but fossil, from the caves of Wellington Valley, approaches very much to the living species. The wombat is a burrowing animal which remains concealed under the ground during the day, quitting its hole at night to feed. Its food consists chiefly of roots and grasses.

Fam. 3. Phalangistidæ, derives its name from the peculiarity of having the second and third toes of the hinder foot united in a common integument. They are expert climbers and live upon trees, feeding upon their leaves, buds, and fruits. Nocturnal in their habits, the phalangers remain concealed during the day on the branches or in the hollows of trees. If we except the section of *Petaurus* they may be described as not very active in their movements. The upper jaw is furnished with six incisors and the lower with two, nearly horizontal or directed obliquely upwards; a canine on either side of the upper jaw. The molars may vary somewhat in the same species; one pre-molar and four molars generally. This family includes three genera: *Phascolarctos*, *Phalangista*, and *Petaurus*.

The genus *Phascolarctos*, which comes nearest the wombats, is characterized by the absence of a tail, a stout body, a moderate head, and by the two inner toes of the fore feet being slightly opposable to the remaining three. It contains but one species, which inhabits New South Wales, the koala (*P. cinereus*), called frequently by the colonists "native bear." It is usually about two feet in length, and when on all fours stands ten or eleven inches in height. Its limbs are of moderate size and of great strength.

The genus *Phalangista* has a prehensile tail, and for the sake of convenience may be divided into four sections. In the first, *Cuscus*, the basal portion of the tail only is covered with hair; the ears are short, almost hidden by the fur of the head, and the eyes with vertical or nearly vertical pupils. The species of this section are of moderate size, and have a dense fur more or less woolly in its texture. They are confined to the islands of Celebes, Amboyna, Banda, Waigiu, Timor, New Guinea, and New Ireland. In *Trichosurus* the tail is densely clothed with fur, with the exception of a part of the under surface commencing at the point, and more or less extended towards the root of the tail; ears distinct, usually long; eyes with the pupil round. Fore feet normal. The species of this section inhabit Australia. The section *Pseudochirus* includes the species with the two inner toes of the fore-foot separated from, and partially opposed to, the other three; the tail clothed, excepting at the apex beneath, with short adpressed hairs; the ears short and rounded; and with six molar teeth, forming a continuous series, on either side of the upper jaw. Inhabits Australia. In *Dromicia* the ears are moderate, nearly naked, and folded; toes with the nails small; tail covered with small adpressed hairs, excepting at the base where it is covered with fur like that of the body, naked beneath at the extremity. Small species, inhabiting Australia and Van Diemen's Land.

A fossil species of Phalangista, agreeing in its general features with *P. vulpina*, has been discovered in the caverns of Wellington Valley.

The genus *Petaurus*, or flying phalangers, is composed of those Phalangistidæ provided with a membrane extending from the fore to the hind legs, and filling the interspace of these legs; the tail is well clothed with hair throughout, and generally very long. In the section *Petaurista* the ears are broad, rather short, rounded, and densely clothed with long fur on the outer surface; the toes of the fore feet nearly equal in length; the flank membrane extending only to the elbow joint; with seven well developed molar teeth in the upper jaw and six in the lower. The true molar, provided with pyramidal cups. The petauri are nocturnal in their habits, and hide during the day in the hollows of trees. In *Belideus* the ears are long and nearly naked; the tail bushy; the lateral membrane extending to the outer finger; the two outer fingers of the hand are long and equal to each other, or very nearly so; the second and third fingers distinctly shorter than these; the second the shortest of the two latter, and the inner, or first finger, very short. The *Acrobata* have a tail moderately long, clothed above and beneath with short adpressed hairs, and fringed on either side with long hairs; the ears are moderate, well clothed externally with fine hairs; the feet provided with small claws, the thumb of the hind foot is large, the flank membrane scarcely extending to the wrist. The type of this section is the pigmy flying opossum (*A. pygmæus*).

The genus *Tarsipes* includes a very remarkable species (*T. rostratus*) from the western coast of Australia, resembling the phalangista in dentition, only with the difference that the teeth are in rather a rudimentary condition. The head is elongated, the snout pointed as in some Peramelidæ.

It has, however, a long and slender tongue suited for the purpose of collecting honey. The lower incisors are sharp, horizontal, and supposed to assist in piercing and opening a passage for the tongue into the inner parts of the flowers where the honey is lodged. The tail is long, slender, rather sparingly clothed with small stiff hairs, and having the skin scaly; a small space at the apex beneath is naked. The limbs are all nearly of equal length, the hind legs slightly longer.

Group 2. Insectivora.

FAM. PERAMELIDÆ, is composed of animals of small size, the largest species known being scarcely equal in bulk to the common rabbit. The head is elongated, the facial part narrow and pointed; the muzzle is naked. The incisors are ten in number in the upper jaw, and six in the lower. There are three pre-molars and four true ones; one canine; making forty-eight in all. The limbs are unequal, the posterior being considerably longer than the anterior. Outer toes of the fore feet, and inner toes of the hind feet, rudimentary or wanting. The tail is usually short, and clothed with small hairs; sometimes long, and clothed, in parts at least, with very long hairs. Peramelidæ have been found in Van Diemen's Land, on the continent of Australia, and New Guinea. They are insect feeders, although they will likewise eat vegetable substances.

Fossil remains of this family have been found in the caverns of Wellington Valley.

The genus *Perameles* may be divided into several sections. In *Macrotis*, the ears are very large, the auditory bullæ in the form of a double bulb; the tail long, and clothed with long hairs; tarsus long, the metatarsus clothed with hair beneath; the innermost toe of the hind foot wanting; the lower half of the fibula firmly jointed to the tibia, and the point with its opening directed towards the head of the animal. *M. lagotis* inhabits Swan River district. In *Perameles* proper, the feet, tail, and ears are proportionally short; the hind foot with a rudimentary inner toe, naked beneath, in front, and at the heel. The fur is distinctly composed of hairs of two kinds, the one forming a soft under fur, the other hairs coarse, flattened, and longitudinally grooved. The tail is clothed with very short adpressed hairs only. The opening of the pouch is turned backwards. The second section contains most of the species.

The genus *Chœropus*, or pig-footed Perameles, has very slender limbs; the fore feet provided with two toes only, and these small, equal, and furnished with short, compressed nails; the hind feet with but one developed toe, the joined toes being very small, and far removed from the extremity of the foot, and the outer toe being represented by a mere tubercle, placed about midway between the extremities of the foot. All the toes of the hind foot are provided with nails. The muzzle is very narrow, and the ears unusually large. The limbs are very long, too, and remarkable for their slenderness. The hind ones are longer than the anterior. The tail

is short and slender. The pouch opens backwards. *C. castanotis*, from South Australia, is the only species known.

Group 2. Carnivora.

Fam. 1. Dasyuridæ, includes Marsupialia, whose habits are either carnivorous or insectivorous. The second and third toes of the hind foot disunited and well developed; the thumb, or first toe, is small or absent. The tail is hairy, and not prehensile. There are eight incisors in the upper jaw, and six in the lower; the canine teeth are well developed; the molar teeth either with trenchant crowns, or with the masticating surface presenting numerous prickly points. Several fossil species of this family have been found in Australia, to which continent the recent species are also confined, with one exception only, the *Phascogale melas*, which is a native of New Guinea.

The genus *Myrmecobius* contains but one species from western and southern Australia (*M. fasciatus*), remarkable for the number of its teeth, four incisors in the upper jaw and three below, two canines above and two below, and eight molars above and nine below, fifty-two in number, the molar teeth provided with prickly points. The head is somewhat depressed above; the muzzle elongated; the snout naked; the nostrils lateral; the ears of moderate size, and pointed; tongue very long and slender. The legs are rather short and strong; five toes to the fore and four toes to the hind feet. The tail is long and bushy. The female is destitute of pouch, and has apparently eight mammæ, arranged in a circle.

The genus *Phascogale* embraces quite a number of species, having four incisors above and four below, canines as usual, three pre-molars and four molars on each side, making in all fifty teeth. The feet are provided with five toes; the inner toe of the hind feet is in the form of a small, nailless, prehensile thumb. The tail is either clothed with short hair throughout, or with short hairs only on the basal portion, the apical having long and bushy hair. The female is sometimes destitute of the pouch; the mammæ are eight, arranged in a circle. In the first section, that of *Phascogale* proper, of which *P. penicillata* is the type, the terminal half of the tail is clothed with very long and bushy hair. In the second section, the *Antechinus*, the tail is clothed throughout with very short hairs. The *P. flavipes* and *leucogaster* are examples of this section.

The genus *Dasyurus* is characterized by having the incisor teeth equal, eight above and six below. There are two pre-molars and four molars on each side, which, with the usual number of canines, makes forty-two teeth. The tail is long, and well clothed with long or moderately long hairs. Some species have no inner toe to the hind feet. The Dasyuri inhabit the continent of Australia and Van Diemen's Land. They are all of moderate size, and nearly all have the fur spotted. *D. hallucatus*, from North Australia, is the smallest species; the *D. maculatus* has the tail spotted, as well as the body, and is confined to Van Diemen's Land.

The genus or sub-genus *Sarcophilus* is intended for those species the body of which is stout; the head short, and very broad; the tail shorter than the body; the pre-molar teeth with the antero-posterior and transverse diameter equal, or nearly so. The *S. ursinus*, from Van Diemen's Land, is the only species known of this section.

It may be compared to a bear in the general proportions of its body and limbs, as well as in the texture of its fur. A fossil species, *D. laniarius*, has been found in the caves of Wellington Valley, and seems to come nearer *S. ursinus;* thus, Sarcophilus would not be exclusively limited to Van Diemen's Land, if it has to contain the fossil species.

Fam. 2. Didelphidæ, or opossums, composed of numerous species, generally of small size, all of them confined to the American continent. Their food consists chiefly of insects; the largest species may occasionally attack reptiles, birds and their eggs. There are ten incisors in the upper jaw and eight in the lower, arranged nearly in a semicircle. In the upper jaw the two foremost incisors are rather longer than the rest, and are generally separated from them by a narrow space. The canines of the upper jaw are the largest. We find three pre-molars and four molars in each jaw. The feet are five-toed, and plantigrade. The general form of most of these animals resembles that of the common rat, but they have the muzzle more elongated, and terminated in a distinct, naked snout. The prehensile tail is almost always very long, nearly destitute of hair, excepting at the root, and covered by a scaly skin. Some Didelphidæ have no pouch, or else one in a very rudimentary state. At first the young remain very firmly attached to the nipple, and subsequently are carried upon the back of the parent, where they retain their position by entwining their tails round that of the mother. The mammæ vary in number from nine to thirteen. The species live in the hollows of trees, or amongst their foliage, where they remain concealed during the daytime, becoming active in the night only to procure their food. One species lives in water, to which habit the webbed feet correspond.

The genus *Didelphys* contains animals without cheek pouches, and in which the toes of the feet are free. It may be divided into two sections, the first including those opossums in which the marsupial pouch is well developed, and the second those in which the pouch is rudimentary or entirely wanting.

To the first section belongs the Virginia opossum (*D. virginiana*), peculiar to North America, together with the Californian opossum and some Brazilian species; the second chiefly includes species from South America.

A fossil Didelphys (*D. cuvieri*) was discovered in the eocene of Paris. A few fragments have been found in European other localities. But the caverns of Brazil have already yielded six or more, which resemble very much those now living in the same country. There is, however, an exception: some fragments seem to indicate a new genus, according to the researches of Mr. Lund, a Danish naturalist. This, however, has not yet been named.

The genus *Chironectes* contains but one species, the water opossum

(*C. variegatus*), characterized by large hind feet, the toes of which are united by a web; the fore feet moderate, and with an unusual elongation of the pisiform bone. Females are provided with a perfect pouch. The ears are large and naked; the tail is longer than the head and body taken together; the fur is dense, short, and somewhat woolly. Its habits are aquatic. It is found in Guinea and Brazil.

The oldest representatives of the order Marsupialia, found in the oolite of Stonesfield (England), belong to the family of Didelphidæ.

The genus *Amphitherium*, or *Thylacotherium*, as both names are used, differs from Didelphis by its molars, which are more numerous and smaller; and from Myrmecobius in having proportionally larger teeth. We know only the lower jaw, which has six incisors, one moderate canine, six premolars, and six tricuspid molars. Two species are already described. The genera *Amphigonus* and *Heterotherium* are other denominations by which the same remains have been designated.

The genus *Phascolotherium* resembles Didelphis still more closely, since it has but three premolars and four molars. The form of the teeth themselves has something of that of Myrmecobius. One single species is known.

The genus *Pterodon* we mention here, although, according to Blainville, it comes nearer Dasyurus. It is known by a fragment of a lower jaw, from the gypsum of Montmartre, in Paris; its true affinities are still a matter of doubt.

Fam. 3. Thylacinidæ. Includes but one genus, *Thylacinus*, with a single living species, *T. cynocephalus*, or dog-faced opossum, about equal in size to the wolf. The form of the head is like that of a dog; the tail about half the length of the body; the fur is short, and closely applied to the skin. Inhabits Van Diemen's Land.

The premolars are more numerous in Thylacinus than in Dasyurus, there being three of these teeth on either side of each jaw. The canine teeth are of large size, of a simple, elongated, conical form, and slightly recurved at the apex. The marsupial bones are wanting. The female is provided with a distinct pouch and four mammæ.

The caves of Wellington Valley have yielded remains of one species of this family, *T. spelæus*.

Order 3. Cetacea.

The order of Cetacea is one whose history is still very incomplete. Although comprising the largest of all mammalia, it belongs to an element in which science is often powerless, and thus naturally escapes our investigation. Cetacea are by no means scarce, but their large size prevents them from being preserved complete in our collections, so that we have no materials for comparison. Occasionally a skull, a jaw, a rib, or a vertebra, are the only data on which we can base our researches. This order, restricted within the limits we assign to it, is characterized by a naked and smooth

skin, under which is found a layer of fat, varying in thickness according to the genera and species. The general structure of the skin is the same as in other mammals, but in addition we find an apparatus of inhalation, composed of vessels of an extreme tenuity, which anastomose together, and are in direct communication with the arteries and veins. They are absorbing vessels common to all animals which live permanently in water. This apparatus is very conspicuous in some fishes.

There is one pair of short limbs, the anterior, constructed for swimming. The toes, being surrounded by a continuous membrane, give to them the shape of a fin, and are used as such, these animals having been created to live in water. The toes themselves possess a greater number of phalanges than in any of the other mammals. The collar bone and hind limbs are always wanting. The posterior extremity of the body terminates in a broad, but horizontal, fibro-cartilaginous, fish-like tail, composed of two lobes or paddles, a right and a left, differently shaped according to the genera and species. On the back, a fin-like organ is often but not always observed; it contains no bones, and consists merely of a fold of the skin. The vertebræ of the neck are very short, and often soldered together. The neck itself cannot be said properly to exist, the head being continuous with the body, as is generally the case in fishes, and only indicated in some of them by a slight contraction in this region of the body. The head possesses so little of motion that it cannot change its situation without the whole body changing it at the same time. The eyes are exceedingly small; the nostrils simple, with one or two openings, through which water is ejected; the external ear never exists; the teeth vary very much in number, and in some genera instead of teeth we find beards, or the so-called whalebones. Their food consists of fishes, crustacea, and mollusca, but never of plants; their pelagic habits preclude a vegetable diet. The only mode of progression among Cetacea is swimming, for which they are especially constituted.

This order may be divided into four families: the whales (*Balænidæ*); the sperm whales (*Physeteridæ*); the dolphins (*Delphinidæ*); and the heterodonts (*Heterodontidæ*).

Fam. 1. Balænidæ, includes those gigantic marine mammals whose jaws are edentate or toothless. Instead of teeth, there are on the upper jaw horny laminæ, situated transversely and parallel to each other upon two rows. These are the *whalebones*, provided along their inner margin with numerous filaments of the same horny nature, by means of which the very small animals on which the whales feed are retained in the mouth. One whale yields from 700 to 1000 such bones, of which the largest is often ten to thirteen feet long, and ten to twelve inches wide at the base. Two genera compose this family.

The genus *Balænoptera* is characterized by an elongated head, which has sometimes been compared to the head of the pike; by the presence of that expansion of the skin called dorsal fin on the posterior part of the back; and by folds or ridges on the anterior and inferior part of the body. It has always been a matter of great difficulty to ascertain the number of species

of whales, and there is a great difference of opinion upon this subject among naturalists. This is very natural, as these great cetaceans are seldom met with by practical observers, and come ashore at periods of long intervals only. Moreover, they cannot be compared directly with one another; and their remains cannot be easily preserved, nor their forms easily reproduced correctly in drawing.

Of the genus *Balænoptera*, three species seem to be well characterized; *B. jubartes*, the rorqual, from the northern Atlantic, and from seventy to eighty feet in length; *B. musculus*, from the Mediterranean, and *B. antarctica*, from the Cape of Good Hope. Some other species are cited as belonging to the northern seas, but are not satisfactorily described, such as *B. gibbar*, seen between Cherie Island and Nova Zembla, *B. acuto-rostrata*, or sharp nosed whale, inhabiting chiefly the Norwegian seas.

The genus *Balæna* differs from the preceding by its great, thick, and obtuse head, in being deprived of the fin-like expansion of the back, and in having the inferior part of the body smooth, that is to say, deprived of the longitudinal folds, more or less deep, as seen in Balænoptera. A single species of this genus is adopted by some authors, *B. mysticetus*, or black common Greenland whale (*pl.* 106, *fig.* 1), the one constituting the chief object of the whale fishery. The head forms one third of the total length. The broad jaw extends along the whole length of the head to behind the small eyes. The œsophagus is narrow, for which reason the whale can swallow small marine animals alone. The color is velvet black, marbled with grey and white; the belly is entirely white. It would be highly interesting to know whether the same species of whale be found in all the fishing grounds, a question which we may be authorized to doubt, as we have some accounts and some facts which indicate a second species around the Cape of Good Hope, *B. antarctica* differing from *B. mysticetus* in some peculiarities in the structure of the bony head. We are told also, that the ice-whale, or *B. islandica*, differs from *B. mysticetus* in having a more lengthened body, and a proportionally smaller head. The two spiracles or air holes represent two small semicircles, which are a little separated from each other, the convexities of which are opposed. The eye is very small, and its shortest diameter is placed obliquely. The general color of *B. islandica* is grey, more or less distinct in its shades. The lower part of the head often appears like a great oval of very shining white, at the centre and circumference of which are seen grey or black spots, irregular and confused.

Several fossil species of Balæna and Balænoptera have been found in the tertiary deposits of Europe. The genus *Cetotherium* is extinct; its remains have been found in the upper tertiary of Russia, and assimilated at first to other cetaceans, when the present genus was established and placed in the vicinity of Balænoptera, from which it differs by the broadness and flatness of the posterior part of the skull, the elevated and thick arch, and the deep temporal grooves. *C. rathkei* is the only species known and found in several localities in the Russian empire.

Balæna mysticetus, Greenland or right whale, is most frequently found

in the Greenland seas, Davis's Straits west of Spitzbergen, Iceland, and Norway, on the coast of Labrador, in the Gulf of St. Lawrence, and round Newfoundland, by the bays of Baffin and Hudson, and in the sea north of Behring's Straits. It is also found among the Philippine Islands, near Socotora (coast of Arabia Felix), and on the coast of Ceylon. It likewise frequents the Chinese seas. Formerly the whales were abundant about Spitzbergen and the Island of Jan Mayen. But since so many whaling vessels have appeared in those places, these animals have left their shores and have retired to the open ocean, where their catching is more expensive, difficult, and dangerous, and less productive. It is by no means improbable, however, that several species will hereafter be found to have been confounded within the above limits. Thus there is pretty good evidence for supposing that the right whale of the Arctic Ocean of America west of Point Barrow, is different from that of Hudson's Bay.

It appears from the testimony of ancient naturalists, that the whales advanced more southwards in the ocean than at present, the numerous vessels traversing the ocean having caused them to retire to more northern regions, where they enjoy a more tranquil life, and are less exposed to destruction. Man, however, has found out their favorite haunts, and yearly spends a season on those fishing grounds, and exposes himself to numerous dangers for the purpose of capturing them. Dewhurst, in his natural history of the cetaceans, states that the black whale comes from the south polar seas in May to bring forth its offspring; remains in the bays of New Holland, Africa, and South America, till August, and on the coasts till November, when it returns in a southwesterly direction.

According to ancient records, the whales captured at the earlier periods of the fishery were larger than those known at the present day. The Greenland whale is, however, said still to reach sixty to seventy feet in length. The greatest circumference measures thirty to forty feet; the length of the tail five to six feet; the width eighteen to twenty-six feet; and the weight of the whole animal about 200,000 pounds. The layer of fat under the skin is ten to twenty inches thick. The lips are almost entirely composed of fat, and yield alone one or two tuns of oil. Generally a large whale gives one hundred and twenty tons of lard, from which thirty tuns of oil are obtained.

When a whaling vessel arrives on one of the above mentioned fishing grounds, the first thing is to set up the so-called crow's nest or watch-house. This crow's nest consists of an old barrel, open above, and which is fastened vertically to the top-gallant mast. One man of the crew, relieved at intervals, stands in it, and keeps watch for the appearance of whales in the vicinity of the vessel. It is often a very dangerous post for the one who takes it; for, besides the intense cold which reigns in those regions, the winds are sometimes so powerful, that the sailor in the crow's nest runs the risk of being thrown out of it.

The appearance of a whale in the neighborhood is indicated by the columns of water ascending from its nostrils into the air, when the animal comes near the surface of the ocean to breathe, and which are visible from

a certain distance. Immediately a large boat, with six or eight seamen and one harpooner, is despatched as noiselessly as possible. When at a convenient distance, the harpooner, seizing a favorable occasion, hurls the harpoon into the side or back of the animal, where it remains fastened by the barb. The whale becomes furious, and takes to flight with rapidity. A long rope, connected with the harpoon, is immediately thrown overboard, in order that the boat may not be drawn under water by the wounded animal. After a certain time (half an hour or an hour generally), the loss of blood has reduced the strength of the whale, which comes again to the surface to breathe, when it receives a new harpoon that makes it disappear again; and this is repeated until the animal is dead. The lives of the whalers are constantly exposed to dangers, of which we have many accounts. A single stroke with the tail of a whale upsets a boat or throws it high in the air.

When dead, the whale lies on the surface of the water, where its fat is carved into large strips, which are hoisted aboard the ship. After the fat of one side is removed, the whalebones are taken, and the body is turned on the opposite side, which undergoes the same operation. The carcase and fleshy remains of the giant are left to sharks, skates, birds of prey, and other carnivorous animals.

The whaling business was formerly more productive than it is now. One hundred and twenty-four individuals are recorded as having been killed by one crew in eight voyages; but now, five to eight whales are considered a rich prize for one voyage.

FAM. 2. PHYSETERIDÆ, or spermaceti whales, is distinguished from the family of whales proper by being provided with teeth on the lower jaw. They are the largest animals among all Cetacea. The size of the head is remarkably large, equalling the half or the third of the whole animal. The upper jaw is excessively broad and deep, and has usually a few indistinct teeth, almost covered with the gum; the lower jaw is long and narrow, and enters into a fissure of the upper jaw, and is furnished on each side with a row of thick conical teeth, more or less obtuse. The dorsal fin exists in a rudimentary condition, or presents itself as a callous protuberance. There is one external opening to the spiracles near the anterior part of the snout. *Physeteridæ* are more or less social in their habits.

The genus *Physeter* is the only one of the family, to which it gives its name. The same uncertainty is met with here as in Balæna, with regard to the number of species. As many as seven species, if not more, have been described, and still are not generally adopted, the characters upon which they are founded being too vague and contradictory. The latest writers on the subject admit but one, *P. macrocephalus* (*pl.* 106, *fig.* 2), the great-headed cachalot, or great spermaceti whale; *fig.* 3 represents another form, that described by Lacépède under the name of *P. cylindricus*, and given by others as the true *P. macrocephalus*. If the differences which the drawings exhibit are copied from nature, and prove not to be sexual, they are obvious enough for specific differences. However, from their gigantic mass, which is rarely presented at once in all its parts to the eye, unless the

spectator be placed at quite a considerable distance, many mistakes might readily have been introduced into drawings, which are, with a few exceptions, the only data in our possession. Thus, the small spermaceti (*P. catodon*), the blunt-headed cachalot (*P. trumpo*), the round spermaceti whale (*P. cylindricus*), the small-eyed cachalot (*P. microps*), the great-finned cachalot (*P. mular*), and the bunched cachalot (*P. gibbosus*), are still doubtful species; the two-toothed cachalot of Sowerby (*P. bidens sowerbyi*) belongs to the family of Heterodonts, but is not sufficiently known to decide upon its real place. It constitutes a genus by itself, nearly allied to Delphinus proper, with a peculiar organic structure, uniting Physeteridæ to Delphinidæ more intimately than any other group.

The fishing grounds for the spermaceti whale are from the Seychelles Isles to Timor, and all the coast of New Holland as far as Shark's Bay, the Japanese seas as far as the Philippine Isles, and to the eastward as far as California.

The fossil remains of Physeter, which have already been discovered, have not been made the subject of a careful examination. Fragments were obtained in France and England, and, we are told, also in North America; but the specimens alluded to here, and upon which the genus *Nephrosteon* has been established, are said to belong to a recent and still living species.

The generic name *Arionius* has, however, been given to a skull discovered in the meiocene of Germany. The upper part of its posterior surface is concave, and along the middle a vertical ridge is seen, vanishing as it goes downwards; the forehead is flat, horizontal, and remarkably broad, decreasing gradually in the elongated snout; the sides, formed by the temporals and frontals, are very concave from above downwards; the nasal canal widens in its way along the snout; the jaws are armed with numerous teeth; those on the lower jaw are longer and more acute, with almost rounded roots, and the crown pointed, conical, scarcely bent, provided in front and behind with a sharp edge, whilst on the sides a slight, not quite regular furrow is to be seen. A single species (*A. servatus*) is described.

This genus may perhaps prove hereafter to belong to the next family, or even an intermediate between both the latter and this.

The genus *Balœnodon* is known by a single fragment of a tooth, whose structure differs from the same parts in Physeter in having the dentine layer thicker. The species is designated under the name of *B. physaloides*.

Fam. 3. Delphinidæ, constitutes a very natural group among Cetacea. It is composed of the smallest species of the order, although some of them attain a considerable size, as between twenty-five and thirty-six feet in length. The dolphins have a fusiform body, which seems completely deprived of a neck, the anterior region of which terminates by a snout more or less elongated, whilst the posterior region, the tail, is terminated by the horizontal fin common to all Cetacea. The size of the head is not disproportionate when compared to the body. The jaws are nearly of equal length, and both are furnished with a row of more or less conical or compressed teeth, varying in number in the particular species. They are developed on the margin of the maxillaries, and in some species inserted in

a groove of the socket rather than in a proper socket for each tooth. From this disposition they have but little adhesion, which a slight effort may displace. The number of teeth varies among individuals of the same species as well as among the species themselves, as if these organs hold but a secondary importance in the existence of the dolphins. The spiracles or blow-holes, after traversing the upper jaw, unite without in a single orifice, which is in the form of a crescent, and is situated at the top of the head. Their organs of sense seem to be in equal number with those of the other mammals, although most of them are less developed. The eye is very small, and furnished with narrow eyelids deprived of eyelashes; the pupil is cordiform. The external orifice of the ear is scarcely perceptible. The tongue is thick, short, smooth, susceptible of but very little motion, and sometimes fringed on its margins. The sense of touch is rendered very obtuse by the fact of their having a smooth skin deprived of hairs, and the presence of a layer of fat underneath. The seat of the sense of smell is not yet known. Besides the tail and its fin, the dolphins have, as organs of motion, two pectoral fins, and often on the middle of the back a fold of the skin which has the appearance of a fin.

The genus *Delphinorhyncus* is characterized by a vaulted head and an elongated and narrow snout, with or without conical and crooked teeth. An osteological character is found in the bony structure of the head. The *D. micropterus* is distinguished by its small dorsal fin and the want of teeth; it was found only once at the mouth of the Seine. Its geographical range is unknown. The second species of the genus, *D. coronatus*, is the largest of the family. Its lower jaw is a little longer than the upper one; both are beset with small, conical, very acute teeth, more numerous on the lower than on the upper jaw. The dorsal fin is semi-crescent-shaped; the caudal forms a complete crescent. The head is rather small in proportion. There are two concentric yellow circles on the forehead, whence the specific name is derived. This species is very common in the Arctic seas around the island of Spitzbergen. A third species, very imperfectly known as yet, is *D. frontatus*, quite distinct from the two preceding. The jaws are very much elongated, narrow, and thin, provided with twenty-four to twenty-five teeth on each side of both jaws. The forehead is much vaulted; the dorsal fin reduced to a mere fold of the skin. The pectorals are scythe-shaped, and the caudals concave. The blow-hole is immediately above the eye; its convexity being turned towards the snout. The haunts of this species are not accurately known.

The genus *Delphinus* is distinguished by the form of the snout being less elongated and broader than in the preceding. The species are numerous, and found in every ocean; none of them are of a considerable size. A dorsal fin generally exists, a single species only wanting this appendage. The most common one, *D. delphis* (*pl.* 106, *fig.* 4), congregates in numbers of individuals, and is met with in the Mediterranean as well as in the Atlantic and northern seas and near the equator. Its history, however, is little known, although spoken of by the ancients. It never reaches a length of more than six or eight feet. Its large jaws are covered with thin lips sus-

ceptible of but little expansion. There are from thirty-two to forty-seven teeth on each side according to the age of the individuals. These conical, acute, and a little crooked teeth are slightly dilated on their middle. They are larger on the middle of the maxillaries than at their extremities, but are as simple in their roots as in their crown. When the jaws close, the teeth of one jaw lodge themselves in the intervals left between those of the other. The use of such teeth is to retain prey rather than to masticate it, for they swallow their food entire. The *nesarnak* or *nisarnak* of the Greenlanders (*D. tursio*) is another species of this genus, known also under the name of bottle-nosed whale. It is quite rare, being seldom seen near the shores. It differs from the common dolphin by a shorter snout and a smaller number of teeth, the form of which is obtuse. The body is short, the snout flattened above, the color entirely black with the exception of a small portion of the abdomen, which is whitish. Nearly forty species of Delphinus are described or mentioned in Cuvier's "Histoire Naturelle des Cétacés," many of which are still very doubtful, as they were never examined, but only seen in open sea from vessels. We would only mention one species more, *D. peronii*, from the south of Van Diemen's Land, as it is deprived of a dorsal fin, the only one of the genus as it would seem. The lower part of the body and the snout are completely white, a peculiarity which caused Peron to bestow upon it the name of *D. leucorhamphus*. Several extinct species of Delphinus are described as peculiar to the old world. Lately another species has been detected in the State of Vermont, which differs from all others.

The genus *Inia* resembles closely the dolphins proper by the general appearance of its external form and proportions. The snout is, however, more elongated, the pectoral fins broader, and the dorsal fin represented by a mere elevation of the skin. But the most prominent character is derived from the teeth, which are nipple-shaped. Only one species is known of this genus, inhabiting the rivers of the province of Moxos, South America. This is the *I. boliviensis*, which is said to attain a length of twelve feet. The angle of the mouth extends as far back as the eyes. The mouth itself is linear and only a little arched posteriorly. The skull is depressed, the snout thin, nearly cylindrical, and obtuse at its extremity. The number of teeth ranges from one hundred and thirty to one hundred and thirty-four; sixty-six or sixty-eight in the upper jaw, and sixty-four or sixty-six in the lower. Their surface is rough with deep interrupted grooves. On the front of the jaws the teeth are conical and crooked, whilst the others are thicker.

The genus *Platanista* comprehends one single species from the river Ganges, representing with the genus Inia the family of dolphins in the fresh waters. The chief character of the genus consists in the narrowness of the jaws, with thin and prominent crests projecting forwards from the maxillaries on each side of the blow-hole. The *Pl. gangetica* reaches seven feet and more in length. The head is short and rounded; the beak long, thin, narrow, without lips, dilated upon its extremity. There is a rudimentary dorsal fin; the pectorals are very large, and the caudal nearly even.

The genus *Phocæna*, Porpoises, is easily recognisable by the shortness of the snout, which can scarcely be distinguished from the forehead. The jaws, however, are elongated, and very distinct from the skull when the soft parts are removed, which in the living condition give to the head and snout that roundness which distinguishes this genus. The porpoises live associated in large numbers, and sometimes ascend rivers far from the sea. Their food consists of fishes and molluscs, which they consume in large quantities. *P. communis* is the most common species met with in the European seas, and is often caught by fishermen. A species very much related to it, and with which it has been confounded until very lately, is peculiar to the American shore of the Atlantic (*P. americana*). It differs from the former in having the teeth grooved on the broad faces near the summit, so as nearly to divide them into three lobes, whilst in *P. communis* they are smooth. The dorsal fin is serrated and tuberculous. The largest species of this genus, the common grampus, *P. orca* (with some authors *Orca communis*), measures from twenty to twenty-four feet in length, with a body of proportional bulk. The snout is very short, the dorsal fin very high, the teeth large and in small number, eleven in each side of both jaws, conical and a little bent backwards. Those near the extremity of the lower jaw are worn off first. The upper part of the body is black, the lower white, and a white oblong spot above the eyes. Found in the Mediterranean and the Atlantic. The *P. gladiator*, or sword grampus, is remarkable for its dorsal fin, which is higher than the body itself under it. The skull is vaulted, the snout depressed, very obtuse, and the lower jaw a little longer than the upper one. This species lives in Davis's Straits, on the coasts of America and Spitzbergen, in troops of from six to eight. The *P. globiceps*, also large and bulky, has a snout still shorter and more rounded, and a large triangular dorsal. The number of teeth varies very much; in adult specimens each jaw has from eighteen to twenty-six of them. Their form is conical, slightly curved inwards at their tip. This species keeps the open seas, but was once seen at the mouth of Charles River, between Boston and Charlestown (Mass.). A similar species, *P. rissoana*, is found in the Mediterranean, and has a snout still shorter, a character which has led some naturalists to place it in a special genus, *Globicephalus*, which included those porpoises with a round and more or less spheroidal head. Some other species of Phocæna are described in systematic works.

The genus *Delphinapterus* includes only one species as far as known, the beluga or white whale, whose characters consist in the absence of a dorsal fin, instead of which it has only a kind of longitudinal projection on the back. The head is proportionally small, spheroidal, and the snout truncated, or rather rounded off. Both jaws are equal, and furnished with nine or ten small teeth, blunt at the top, but unequal and distinct from each other. The *D. beluga* is a native of the northern seas, the Arctic, and especially of Hudson's Bay and Davis's Straits.

The genus *Oxypterus* is known only from vague information. Rafinesque established it for a species from the seas of Sicily, calling it *O. mongitori*. According to Quoi and Gaimard (Voyage de l'Uranie, Zool., p. 86, pl. ii.,

fig. 1) the genus would rest upon the presence of two dorsal prominences, one situated near the fin and the other near the head. The form of the snout is unknown, so that we are in doubt as to whether it is elongated as in the dolphin, or truncated as in porpoises. The naturalists of the "Uranie" met a second species in 1819, between the Sandwich Islands and New South Wales, in 5° 28′ north latitude. This is known also under the name of *O. rhinoceros.*

FAM. 4. HETERODONTIDÆ, is difficult to characterize on account of the dissimilarity between the few genera and species of which it is composed, and the little knowledge possessed of them. The teeth are of different sorts, always few in number, and sometimes even wanting in the adult state.

The extinct genus *Ziphius*, which we place here for the sake of convenience, is intermediate between Hyperoodon and Physeter, and seems to have preceded and foreshadowed in the tertiary epoch these two genera of our days. Three European species are described, but none of them are fully known.

The genus *Hyperoodon* is based upon a singular structure of the head, which consists of a large and elevated apophysis rising from the middle of each upper maxillary, giving to the posterior part of the head that peculiar shape which characterizes it. Their teeth, two in number, small, acute, near the extremity of the jaw, sometimes hidden under the gum or wanting, whence the name of *Delphinus edentulus*, and the generic appellation of *Aodon.* The absence of teeth has led some others to place this animal among whales proper, but as it has no whalebones others have been induced to bring it nearer the dolphins. Only one species is described as belonging to this genus, the *H. baussardii* from the northern European seas. It has a dorsal fin and small pectorals. The beak is detached from the forehead, which is rounded and abrupt. The eyes are quite distant from the angles of the mouth, a peculiarity which distinguishes it from the dolphins proper. The body is fusiform, and tapers rapidly away from the dorsal fin to the tail.

The genus *Heterodon* must provisionally include the two-toothed cachalot of Sowerby (*Physeter bidens sowerbyi*, Dewh.), which we shall designate by the name of *H. sowerbyi.* Its characters consist of a narrow and elongated snout, the upper jaw longer than the lower, which receives it; one single tooth below on each side, compressed, and obliquely directed backwards, placed in the middle of the margin of the jaw. A blow-hole, crescent-shaped, with the concavity forwards. This species was observed on the coast of England. The two-toothed dolphin (*Delphinus bidens*) resembles the Hyperoodon by the form of its head. Its place is, at any rate, in this family; but whether it belongs to the genus *Heterodon*, or to any other, we cannot decide at present.

We place here the genus *Arnanacus* of Lacépède, created for one species of cetacean, called by the Greenlanders *Arnanak*, from the supposed purgative qualities of its flesh and fat. It has also been referred to the genus Monodon, and is the *M. spurius* of the "Encyclopédie Méthodique." The *Arnanicus grœnlandicus* has one or two small obtuse, conic, and crooked

teeth at the extremity of the upper jaw, none in the lower, and a dorsal fin; thus, much nearer Hyperoodon and Heterodon than to Monodon. It is one of the rarest species of Cetacea, inhabiting the main ocean, seldom approaching the shores, and feeding chiefly upon pelagic molluscs.

The genus *Monodon*, or narwhales, resembles the porpoises in the spheroidal head, but is deprived of a dorsal fin like Delphinapterus. The structure of its skull brings it nearer the dolphins proper. The character by which it is distinguished from either one of them is the presence of tusks instead of teeth, originating from an alveolus common to both of the upper maxillaries and premaxillaries, which tusks are directed horizontally forwards, and reach a length of eight or ten feet. They are more or less twisted. Generally only one tusk is developed, the other remaining rudimentary. The mouth is small; the dorsal fin rudimentary. The narwhales are chiefly found in the polar seas, where they live in troops more or less numerous.

Monodon monoceros (*unicornis* and *bicornis*) inhabits the seas of Greenland and Spitzbergen. Another species is mentioned by Dewhurst, under the name of *M. microcephalus*, seen near Spitzbergen.

Fossil remains of Monodon have been found in the upper tertiary beds of England and Russia, but have not yet been fully examined, so that the species are not determined and not compared with the living ones.

Order 4. Herbivora.

Group 1. *Sirenidia.*

The section of *Sirenidia* is composed of some aquatic mammals formerly placed among Cetacea, although by their herbivorous habits they have always constituted a natural group. Ancient writers have transmitted to us many fables respecting these animals; but modern investigation has removed the thick veil of ignorance which has enveloped this subject, especially with regard to the mermaids, those fabulous human-like beings, with the posterior parts of the body covered with scales, and terminated by a fin. It is perhaps unnecessary to state that no such things as mermaids exist in nature. The seals, too, share with the Sirenidia the honor of giving rise to the mermaids and sirens of ancient and modern times. The pretended specimens usually exhibited in peripatetic or stationary museums, are generally fabricated from skins of monkeys artistically combined with those of fishes.

The general form of the body of the animals comprised in this group is sub-cylindrical, tapering posteriorly, where it terminates by a horizontal fin similar to that of the whale. The head is somewhat detached from the trunk by a neck more or less apparent, and rises above the horizontal line of the body. The lower jaw is generally shorter than the upper one; both are furnished with teeth with a flat crown, more or less irregular, and adapted for the grinding purposes suited to their herbivorous habits. Instead

of the blowing-holes of Cetacea, we find here nostrils constructed like those of other mammals. There exists no external ear; the eyes, proportionally small, are provided with a nictitating membrane, which is wanting in Cetacea; the upper lip and snout are beset with thick beard-like bristles; the skin itself is generally smooth, and deprived of hair. Of the locomotive organs, the anterior ones alone are present, as in Cetacea, and similarly constructed for swimming; for this its adaptation is very great. The posterior limbs are completely wanting. Sirenidia live in society, not far from the shores, and at the mouths of rivers. They often go ashore to feed upon marine or aquatic plants, and may occasionally drag themselves on dry land, which Cetacea never do.

Several fossil genera of this group have already been described, and we may expect some more to be discovered hereafter. The living genera are only three, *Manatus*, *Halicore*, and *Rytina*, comprising a very small number of species. We shall first introduce the extinct members, as the oldest data of the history which we endeavor here to relate.

FAM. 1. DINOTHERIDÆ. The genus *Dinotherium* is founded upon a gigantic fossil from the tertiary beds of Germany, which created a great sensation at the time of its discovery. Different opinions have been entertained with regard to its true zoological affinities. First placed near the tapir and mastodon, it is now generally associated to the Manati and other Sirenidia. At any rate, the Dinotheria are pachyderms, and were never mistaken as such. And when brought in the same group with Manati, this fact ought to have revealed to us the affinities of the so-called herbivorous Cetacea with pachyderms, of which they form the lower grade, and among the latter the Dinotheria are the lowest. Their lower jaw is terminated by two tusks, curved downwards and backwards. The existence of great sub-orbital holes, and the form of the nasal bones, have induced the belief that Dinotherium was provided with a proboscis similar to that of the tapir and elephant. The molar teeth, five above and five below, remind us of those of the tapir and manatee. Several species have been described from the tertiary beds of Europe. *D. giganteum* is the largest and best known. Its habits are thought to have been similar to those of the Manati; it frequented the mouths of rivers, feeding upon aquatic plants; the tusks were occasionally used to force them out of the ground. A species of Dinotherium has been announced from the eocene of South Carolina.

The genus *Metaxytherium* possesses all the osteological characters of the Dugong, as also its tusks, but the grinding teeth resemble those of the Manati. Although several species are known to have existed in Europe during the tertiary epoch, they are imperfectly characterized. Some of their remains have previously been referred to the genera Hippopotamus and Manatus, until Christol created the genus which we here record.

The genera *Halitherium* and *Pygmeodon* come near the Manati and Dugong, but are too imperfectly known to allow us to give a more detailed account of their history.

The genus *Cheirotherium*, with a skull and skeleton constructed like the skull and skeleton of the Dugong and Manati, is provided with teeth,

reminding us of those of the Hippopotamus. The remains of but one species, *C. subapenninum*, of this genus have been found in the tertiary deposits of Italy.

A fossil genus Chirotherium has been established from some foot-prints, at first referred to the opossum family, and afterwards believed to be a gigantic batrachian animal. Although differently spelt, its etymology is the same as that of Cheirotherium, making two homonymous genera in the nomenclature, one in the class of Mammalia, another, still doubtful, in the class of reptiles. The latter is probably identical with Labyrinthodon.

The genus *Cymathotherium* is placed among Sirenidia, perhaps with no propriety. The only part which we possess of that animal is a fragment of the lower jaw. This jaw seems to bear but one single developed tooth, a little elevated above the margin of the bone. The crown of the tooth itself is compressed, and its base dilated; the root is long, exteriorly curved; its surface is furrowed, and the inner side exhibits a deep groove. *C. antiquum* is from the diluvial deposits of Germany. Its size, we are told, reached that of the Dugong.

The genus *Toxodon* bears a great resemblance to pachyderms, and will undoubtedly prove to be a synthetic type of the latter and Sirenidia. Its real affinities, however, are not understood, inasmuch as great diversity of opinion exists among naturalists on their account. It is compared alternately with Rodentia, Cetacea, Edentata, and Pachydermata. By some it is brought near the seals; by others near the pachyderms, which it resembles most in the structure of its teeth. Now, if Toxodon approximates to pachyderms, and was constructed to lead an aquatic life, it must enter the group of Sirenidia. Toxodon had no canines; trenchant incisors. The molars recall to the mind those of Edentata; they are seven in number on each side, and implanted in the jaws with the convexity outwards.

The only well ascertained species of this genus was found at Bahia Blanca, on the banks of the Rio Negro (South America). Another, but doubtful species, is established upon a humeral bone found in Colombia (South America).

Fam. 2. Manatidæ. In the genus *Manatus*, the grinding teeth are more numerous than in the others of the same family, being eight in number. The crown of these is square and flat, marked with transverse ridges, and provided with a root distinct from the crown. The incisors are in a rudimentary state in the young; the canines constantly wanting. The pectoral fins exhibit on their edge the tips of four nails. The caudal fin is rounded. The species hitherto known in a recent state are few in number, and seem to differ but little from each other. *M. americanus* or *australis* is found on the Atlantic coast of South America, from which it ascends into the rivers, especially the Amazon and tributaries. *M. senegalensis* is another, from the western coast of Africa. This species is smaller than that of America, being seldom more than about eight feet long. Its color is blackish ash. A third but doubtful species, *M. latirostris*, is said to be peculiar to East Florida, the Gulf of Mexico, and perhaps the West Indian seas.

The latter might be identical with the species of South America. Fossil remains of the genus Manatus have been found in the tertiary deposits of North America. We possess but vague information respecting the fossil Manati of Europe. No one has been as yet satisfactorily determined.

FAM. 3. HALICORIDÆ. The genus *Halicore* is distinguished from Manatus by the teeth, which are destitute of a root properly so called, by their plane upper surface, and by powerful, tusk-like incisors at the upper jaw, and covered by the lips. The anterior limbs are uniform, and destitute of nails. The caudal is crescent-shaped, as in Cetacea. The nostrils are placed near the upper surface of the snout, and quite distant from its extremity. The inter-maxillaries and lower jaw are bent downwards, another striking difference between this genus and Manatus, in which both jaws are nearly straight. *H. indicus*, the only species known, inhabits the East Indian archipelago.

FAM. 4. RYTINIDÆ. The genus *Rytina* is remarkable for the structure of the outer layer of the skin, which possesses below the thin and deciduous epidermis, a crust composed of fibres or tubes, placed vertically on the skin. This crust is so hard that steel can scarcely penetrate it, and when cut it resembles ebony by its compact tissue and its color. The entire surface is unequal, rough, cracked, and destitute of hairs. The lips are double, an internal and an external one. The jaws are provided on each side with a plate or compound tooth, destitute of a root, and resting on the jaws. There are no tusks. The caudal fin is crescent-shaped; the pectoral fins, or anterior limbs, have no nails externally visible. One single species is known, *R. borealis*, inhabiting Behring's island. It reaches twenty-four to twenty-five feet in length, and is therefore the largest of the living representatives of the family, and was only exceeded by the gigantic Dinotherium.

Group 2. Trichechidæ.

The Walruses constitute quite a peculiar group, hitherto placed near the seals on account of a general resemblance in the form of their body and in the similar structure of the limbs, which are four, the normal number in Vertebrata. In the head and teeth, however, they differ widely. There are neither incisors nor canines in the lower jaw, which is compressed anteriorly in order to pass between two enormous tusks, sometimes two feet in length, which project downwards from the upper jaw. The molars are all short, obliquely truncated cylinders; there are four of them on each side, above and below, but at a given age two of the upper ones fall off. The upper jaw possesses two deciduous incisors, which in form and structure are similar to the molars. The walrus differs chiefly from Sirenidia by the presence of hind limbs, and short hairs covering the body, to which characters we may conveniently add the tusks. They have received the vulgar appellations of *morse*, *horse-whale*, *sea horse*, *sea elephant*, and also *sea cow*, now more restricted to Manati.

In removing the walruses from the seals, to bring them near the pachyderms, we agree with the views brought forth a year ago by a most skilful American anatomist (Proceedings of the Boston Society of Natural History, III. 1850, p. 242).

Sirenidia and Walrus together undoubtedly belong to that great group called Pachydermata, but do not constitute a single series. The pachyderms need to be revised carefully, and the numerous extinct genera once more compared with both the aquatic and terrestrial living types.

FAM. TRICHECHIDÆ is the only one of the group, and contains but one single genus, the genus *Trichechus*, composed only of one well ascertained species, *T. rosmarus* (*pl.* 114, *fig.* 3), of the history of which the following is an extract from Bell's History of the British Quadrupeds :—

"The form of this animal is extremely unwieldy ; its bulk, in comparison with its length, being greater than in any other form of *Phocidæ*. This, with the relative small size of the head, the full, thick muzzle, and the long tusks, directed downwards, gives it a most strange appearance. Like the seals, it frequents principally the northern regions, where multitudes of them associate in herds on the rocks or ice fields, throwing themselves off on the first approach of danger into the sea, where they are as active and as much at home as the seals themselves. The walrus, however, from the form and structure of its teeth, cannot live upon fish to the exclusion of vegetable food. The small number of grinding teeth, and more especially their extreme shortness and rounded form, are calculated rather to bruise the half pulpy mass of marine vegetables, than to hold and pierce the slippery hardness of the fish's scaly cuirass. One of the most remarkable peculiarities is the form and size of the superior canine teeth, which are directed downwards, and are extremely long and powerful, constituting a pair of defences of immense strength.

"The walrus is found only in the colder regions; it comes often on shores or on the ice, and remains there sometimes in herds of forty, eighty, a hundred or more, for days together, until they are driven to the sea either by alarm or hunger. They are often killed on land at Spitzbergen and other northern coasts, by means of a lance or spear, for the sake of their oil, and the ivory of their tusks, which is much more valuable than that of the elephant, on account of its superior whiteness and density. Of late years, the pursuit of these animals has greatly diminished their numbers, or at least taught them more caution, and rendered them extremely fearful of their arch-enemy. In the water, the chase of the walrus is exceedingly difficult. The extreme thickness and hardness of their skin render it impervious even to the stroke of the harpoon, unless well directed and sent with great force.

"Before the persecution above alluded to had taught them to be apprehensive of the approach of mankind, they were often found at a considerable distance from the sea; and as the hunters placed themselves between them and the water, numbers were intercepted in their retreat, and readily destroyed. Of the carcases of the first that fell the hunters made a sort of barrier to oppose the remainder; and in this way, on some occasions, three

or four hundred have been killed. When wounded they become furious, striking from side to side with their long tusks, seizing and breaking asunder the weapon with which they are attacked, and at length, placing the head downwards between the fore paws, roll themselves like an immense ball into the sea."

The walrus was formerly met with along the Atlantic coast of New England, and about the year 1650 extensive fisheries were carried on along the coast of New Brunswick. Fossil species of the same genus are found within the limits of the United States, one of which is described under the name of *Trichechus virginianus*. Others, as it seems, have left their remains in the old world.

In size the walrus surpasses the largest ox, and attains twenty feet in length. The body is covered with short yellowish hair.

Group 3. Pachydermata.

The group of *Pachydermata* is a very natural one amongst the Herbivora of our days. It includes those hoofed mammals which are not ruminants. Among terrestrial animals they are the largest. They are characterized by the thickness of their skin, to which their name has reference; most of them are bulky and heavily built, even in the species of middling size. The clavicle or collar bone is absent: the pachyderms have limbs destined to support the body, and not for seizing any object. They are terrestrial or semi-aquatic, and constitute the natural ascending transition from the Cetacea and Sirenidia.

FAM. 1. ANOPLOTHERIDÆ. This family combines the characters of the ruminants and those of the multungulate or many-hoofed pachyderms. The skeleton still presents much of the slender and light forms of the two-hoofed ruminants. The genera composing this family are all extinct, having only existed during the tertiary epoch. The typical forms lived in the eocene period, and towards the end of the meiocene they became less numerous, disappearing completely during the pleiocene period.

The genus *Anoplotherium* is considered as having some affinities with the rhinoceros, the horse, the hippopotamus, the hog, and the camel; and indeed this is not at all surprising, for Anoplotherium has preceded all these genera in the history of life upon the surface of our globe. They are the prototypical or synthetical creation, combining, during the eocene, the forms which were to appear distinct at a later date. Anoplotherium has forty-four teeth disposed in a continuous and uninterrupted series, a character found nowhere else except in man. Complete skeletons of Anoplotherium are preserved in collections; the feet are provided with only two developed toes, as in ruminants; in some species, however, there are small accessory toes. The Anoplotheria were bulky and stout animals possessing a large and thick tail, calling to mind that of the otters, whence the opinion that these animals were divers and had habits similar to those of the hippopotamus. Remains of two anoplotheria have been found in Paris; the *A. com-*

mune also existed on the Isle of Wight. Another species is mentioned as peculiar to the Sivalik Mountains in Asia.

The genus *Xiphodon* is composed of one species of Anoplotherium, the light and slender form of which seems to indicate great agility, comparable only to that of the gazelle and the roe. The tail is short and slender.

The genus *Dichobune*, with the same essential characters, is of the size of the hare, with the same proportion between the anterior and posterior limbs, which according to all probability gave to them a similar walk. Three species occur in the tertiary basin of Paris, and a fourth is peculiar to England.

The genus *Oplotherium* exhibits great affinities with Anoplotherium, and more especially with Dichobune, but differs by an essential character; the canines, which in the preceding genera are scarcely to be distinguished from the incisors, are prominent and curved like those of the tapirs and Palæotherium. Species of this genus have been found in France and Germany. The genus *Microtherium* was established upon one of them.

The genus *Macrauchenia* combines in a remarkable manner the forms of the camel and Palæotherium. The head and teeth are yet unknown; but the vertebræ of the neck indicate that this region of the body was elongated, as in the lama. The legs or limbs resemble those in ruminants, but the feet are constructed as in pachyderms. The only species known was found in Patagonia, south of St. Julian harbor. Its size was nearly equal to that of the rhinoceros and hippopotamus of our days.

The genus *Chalicotherium* is known only by its dentition, which indicates an affinity with Anoplotherium. Two species have been found in the meiocene deposits of Germany, whose bulk, it is supposed, reached that of the rhinoceros.

The genus *Cainotherium* we merely mention here. It is but little known. In the opinion of some it is the same as Chalicotherium, and in that of others the same as Oplotherium. Two species, we are told, have been found in the eocene deposits of France.

Fam. 2. Hippopotamidæ, or Pachydermata proper, in the actual fauna, generally comprehends clumsy and colossal beings the limbs of which are very short, the hind feet with three and the fore feet with three or four hoofed toes. The hoofs themselves are of irregular forms, as in the following family, and all of them rest on the bottom. For this reason there are no posterior rudimentary toes. The dentition exhibits both analogies and affinities with the other families of the order. The incisors are either wanting or vary in number from two to six. Canines seldom exist, and where they happen to be present their length is not disproportioned. The molars are generally seven in each jaw, sometimes only six in the lower, exhibiting various forms. The few living genera, with equally few species, inhabit the warmer parts of both the old and new worlds. Fossil remains of species belonging to the recent genera, together with others belonging to genera entirely extinct, have been found in the tertiary beds of America, Europe, and Asia.

The genus *Hippopotamus* is characterized by a very massive and naked

body, very short legs, the belly reaching nearly to the ground; by an enormous head terminated by a broad muzzle. The tail is short; the ears and eyes small. There are to each foot four nearly equal toes terminated by little hoofs. These animals frequent rivers, and feed upon roots and other vegetables. They are stupid and ferocious. The *H. amphibius* from southern Africa is represented on *pl.* 111, *fig.* 8. Hippopotami were formerly found throughout Egypt, very abundantly in the Nile, but are confined now to Nubia and to the rivers of central and southern Africa, in Senegal, Zaira, and Gambia. During daytime they keep in the rivers, hidden among marshy grasses. They are good swimmers, and can remain immersed a very long time. When swimming they snort heavily, and exhibit only the snout above the water. They are often met with in flocks of fifty individuals or more. They sleep and lie exposed to the sun in shallow water. The female produces only one young at a time. Hippopotami are not dangerous to man, unless attacked by him and wounded. They are killed either by the musket or the harpoon. The Africans make use of the fat and tongue as food, the skin for whips, and the canines (sometimes two feet in length) are worked in the same way as the tusk of the elephant, and seem to be a finer article. A small species, *H. liberiensis*, is found in the rivers of Liberia, where it is rather common. Fossil species of Hippopotamus are quite numerous in Asia, less so in Europe. Their discovery in America is quite recent. Where they possess only four incisors they form the genus *Tetraprotodon*, and when six incisors exist in both jaws we have the genus *Hexaprotodon*. The species with six incisors in both jaws are more numerous than the others.

The genus *Potamohippus* is extinct and little known. It has been established upon some teeth from the tertiary beds of Germany, resembling much the upper canines of the Hippopotamus, or the lower milk internal incisor of the same animals, but with the difference of being deprived of a furrow at their inner surface.

The genus *Siderotherium* was created from a fragment of an upper grinding tooth from the tertiary of Wirtemberg, whose surface is somewhat like that of Hippopotamus.

The genus *Elasmotherium* was established upon a fragment of the lower jaw, and said to have come from Siberia. Since then one tooth was discovered near the Caspian Sea, and a posterior part of a head found on the Rhine has also been referred to it. The molar teeth remind us of those of the rhinoceros; but the enamelled plate of the interior is more undulated, and presents nearly the same complication as in the teeth of the horse, and perhaps still more that in Hippotherium, or horses of the tertiary era, which sometimes undulate. Their elongated and prismatic form constitutes another analogy with the teeth of the horse. The form of the jaw itself, its size and thickness, indicate a stout animal resembling probably the rhinoceros in its general outlines, and reaching the bulk of the largest species of this genus. Its habits were probably also similar to those of the rhinoceros.

FAM. 3. RHINOCEROTIDÆ. The genus *Rhinoceros* is easily distinguished

by the horn-like processes which it exhibits on the nose, and to which its name refers. The horn or horns (there being one or two present) consist of a fibrous and horny substance, resembling agglutinated hairs, and adhering to the skin. Each foot is divided into three toes. There are four incisors above and four below, two being very small or completely wanting, and seven molars on each side. No canines. The rhinoceros of India (*R. indicus*) is represented on *pl.* 118, *fig.* 1, and will give an idea of its clumsy appearance. The African species is provided with two horns on the snout. Rhinoceroses have been much more numerous during the tertiary epoch than in our days, and have inhabited countries from which they are now completely excluded. Their fossil remains have been found from the north of Europe to the south, in France, Italy, England, and especially in Germany. Ten to eleven extinct species are already on record. Some of them are relatively small sized. Several species are known from the eocene of the Upper Missouri. It is perhaps worth mentioning here that the genera *Cœlodonta* and *Acerotherium* have been established on immature specimens of true rhinoceros.

FAM. 4. PALÆOTHERIDÆ. The genus *Palæotherium* is without living representatives, but its outlines have been restored from the study of complete skeletons. The nasal bones resemble somewhat those of the tapir, indicating clearly that Palæotherium had similar forms and a small flexible proboscis. The fore and hind limbs have three hoofed toes. Upwards of twelve species are described as having been found in the old world. The western tertiary deposits of America have also yielded jaws and other fragments belonging to the same genus.

The genus *Lophiodon* comes nearer Tapirus, from which it differs in the structure of the molars, the relative number and proportion of the folds of enamel. A dozen species of this genus have already been made known by fragments more or less numerous. These remains were found chiefly in France and Germany, where the animals referred to lived mostly during the meiocene period.

The genus *Tapirotherium* was founded upon one species of Lophiodon. The genus *Listriodon* is distinguished from Lophiodon by the structure of the teeth. The genus *Coryphodon*, in the actual state of our knowledge, is not certainly distinct from Lophiodon. The affinities of the genus *Tapiroporcus* are still to be investigated, as they might prove, perhaps, relationship with the Suiline family instead of the present one.

The genus *Platygonus* is American, as far at least as our knowledge of irs history goes. Its remains, all belonging to one species, were found in the lead region of Illinois. It presents a peculiarity which is only observed in Hippopotamus, although to a much less degree, consisting in the dilatation of the angle of the lower jaw into a large and broad expansion, concave outwards. The superior canines are compressed, acute, and slightly curved, directed forwards and downwards so as to be entirely concealed by the lips as in Tapirus and Lophiodon. We have, therefore, here a type which combines the characters of several quite distinct genera, although not yet fully understood.

The genus *Anthracotherium* is very remarkable, as it forms a link of relationship between the Anoplotheridæ and Suidæ. By the upper molars they are allied to Anoplotherium, whilst those of the lower jaw resemble those of the hog, and more particularly of the extinct genus Chæropotamus. The remains of several species have been found in the meiocene deposits of central Europe.

The genus *Tapirus* possesses twenty-seven molars, which present two transverse and rectilinear prominences when not worn off. Each jaw has six incisors and two canines, separated from the molars by an empty space. The nose resembles a small fleshy proboscis; there are four toes to the fore feet, and three to the hind ones. For a long time only a single species was known of this genus, the American tapir (*T. americanus*), quite common in Paraguay, of the size of a small ass. It frequents wet places along the rivers of South America. The skin is nearly naked, the tail moderate, the neck fleshy, forming a sort of crest on the nape. Another species is now known to inhabit the Andes. A third, *T. indicus* (*pl.* 111, *fig.* 1), occurs on the eastern continent. Many fossil species, some of them of gigantic size, are on record, three from central Europe, and one from Brazil.

FAM. 5. ELEPHANTIDÆ, or PROBOSCIDIA, is characterized by having an elongated, flexible, and powerful proboscis, an organ of touch as well as of smell, together with very large projecting tusks. There are no canines or incisors, properly so called; in place of them we find the tusks. The toes are five in number on each foot, very complete in the skeleton, but so incrusted by the callous skin which surrounds the foot that their only external appearance is in the nails attached to the edge of this kind of hoof. The representatives of this family are not very numerous in genera and species, as if their enormous size had forbidden a greater profusion. Two genera, one extinct (*Mastodon*), and the other living (*Elephas*), constitute the whole of it; most of the species are extinct.

The genus *Mastodon* is very nearly allied to the elephants. It had, like the latter, a large proboscis, by means of which it could gather on the surface of the earth the plants and roots upon which it fed. The head and neck are short, and could not easily reach to the feet without some such provision. It differs from elephants in the structure of the molar teeth, the crown of which, instead of being flattened above, exhibits small cones arranged in a certain number of transverse rows. In size mastodonts were generally superior to elephants. Many species are described, but some of them are still doubtful. They all lived during the tertiary epoch, and in larger number towards the end of it. They were very common in America, and the discovery of the remains of some of them has from time to time produced a very great sensation. Various names have been applied to these remains. The following belong to the *Mastodon giganteum*, the largest and first species known: *Mammuth ohioticum*, *Mastotherium*, *Harpagmotherium canadense*, *Elephas carnivorus* (the tuberculous crown of whose teeth, when first discovered, led some to imagine carnivorous habits), *Tetracaulodon mastodontoideum*, *Missourium theristo-caulodon*, and many other specific denominations. Species of this genus have left

their remains nearly all over the world. When young, mastodonts are provided with two small, short, and straight tusks at the lower jaw, a character upon which was founded the genus Tetracaulodon, alluding to the presence of four tusks.

The genus *Elephas* comprehends the largest of the terrestrial mammals now living. They are provided with molar teeth or grinders, the bodies of which are composed of a variable number of vertical laminæ, bony in their structure, but enveloped with enamel and cemented together by a third substance called cortical or cement. These grinders succeed each other from behind forwards and not vertically, as in most species of Mammalia. As fast as one tooth is worn, it is pushed forwards by that which comes after it; hence it happens that the elephant has sometimes one, sometimes two grinders on each side, or four or eight in all, according to circumstances. The first of these teeth is always composed of fewer laminæ than those which replace them. We are told that elephants thus shed their teeth eight times; their tusks, however, are changed but once. The elephants of our days are clothed with a rough skin nearly destitute of hair, and are only found in the torrid zone of the eastern continent, where hitherto only two species have been ascertained. The Indian elephant (*E. indicus*) is represented on *pl.* 111, *fig.* 9. The other species belong to Africa. Fossil remains of elephants have been found throughout the whole continent of Europe, in Spain, Italy, Switzerland, Belgium, France, England, Germany, and Russia. But they appear nowhere so abundant as in Siberia, where the tusks have become an active branch of trade. The inhabitants of Siberia explain the presence of those large deposits of tusks and bones by the following fiction: They believe that the soil of their country is excavated by animals of a gigantic stature, which they call *mammouths* or *subterraneous moles*, imagining that these animals are destined to live constantly in the dark, and that they are killed by the light when they dare to approach the surface of the earth. Similar ideas are spread all over the Asiatic continent, for accumulations of such bones have been discovered near the boundaries of China. Elephants also inhabited North America during the tertiary period; fossil tusks, teeth, and bones have been found from the north to the south. The *Elephas primigenius*, or Siberian mammoth, is more commonly found near the Arctic polar ice, and buried in it, as if it had lived there at a given period and been suddenly surrounded by snow and ice in which it is preserved, skin, hair, flesh, and all. We have authentic reports that dogs have been fed upon their flesh. The white bears have probably devoured many of these colossi. Like mastodonts, the elephants were formerly spread all over the surface of our globe.

Fam. 6. Hyracidæ. The genus *Hyrax*, or damans, is constituted by the smallest living pachyderms, which are not larger than an ordinary rabbit, and on that account referred by some to Rodentia. Their molars are similar to those of the rhinoceros, and their upper jaw is furnished with two strong incisors, curved downwards; and at a very early age they are provided with two very small canines. There are four toes to the fore feet and three to the

hind ones, all of them terminated by a very small, thin, and rounded hoof, except the internal posterior, which is armed with a hooked and oblique nail; the upper lip is cleft; the snout and ears are short; the body densely covered with hair; and the tail reduced to a mere tubercle. One species inhabits the Cape of Good Hope; another, *H. syriacus* (*pl.* 111, *fig.* 2), is peculiar to Asia.

FAM. 7. SUIDÆ. In the actual fauna, this family is characterized by a fluctuation in the proportional numbers of the teeth, and by four toes to each foot, by which it differs at once from Anoplotheridæ, with which it would seem to bear some affinity. The number of the molars varies from three to seven; the canines are always distinctly developed; and the incisors may either be absent, or six and less may exist, situated more or less horizontally in the jaw. The two central toes alone touch the bottom with their three-sided pyramidal hoof; the other toes are much developed, as posterior claws provided with hoofs. The nasal bones elongate forward, and terminate by a proboscis-like nose, fitted for digging. The structure of the skeleton is more clumsy than in Anoplotherium, from which the Suidæ are always distinguished by a shorter stature. The living genera of this family contain but four species, and are distributed all over the surface of the globe, within the temperate and torrid zones.

The genus *Adapis*, from the oldest tertiary beds, is considered by some as belonging to Anoplotheridæ, by others to Suidæ. There are four sharp and oblique incisors above, and four below; behind these, and on each side, a stout and prominent canine, straight in the upper jaw, oblique and curved forwards in the lower; the upper molars, seven in number, are variable in form, as also the lower ones, the number of which could not be ascertained, from want of complete jaws. We know but one single species of this genus (*A. parisiensis*), from the eocene of Montmartre.

The genus *Hyotherium* is not yet sufficiently characterized. Its remains were found in Central Europe, and indicate an animal of the suiline family, resembling very much the babiroussa now living in the Indian Archipelago. The number of the incisors is not known; the molars, it is supposed, were six on each side of each jaw. Five species are already described, one of which had first been referred to the following genus.

The genus *Chœropotamus*, therefore, must have some close affinities with Hyotherium, from which it differs in the structure of the molars. There are on each side seven above, and six below, of these teeth, intermediate between those of the peccaries and hippopotamus. Several species have been distinguished; one from Paris, another from Switzerland, and a third from Spain. Undescribed fragments are known from the south of France and Turkey.

The genus *Protochœrus* appears to be an American form, as the only species known was found in Illinois. The canines resemble those of Chœropotamus, but differ from it in having no accessory tubercles on the molars.

The genus *Hyracotherium*, from the London clay (eocene), is very nearly allied to Chœropotamus, by its dentition. The four anterior molars are

proportionally greater and more complicated; the canines resemble most those of the peccaries; the skull, by its form, is intermediate between the damans and the hogs. It exhibits very large orbits, a character chiefly prominent among the timid rodents. Its size is supposed to have been about the same as that of the daman, which is among the smallest of the pachyderms. The only two species known belong to the eocene period, and to the British isles.

The genus *Microchœrus* shows a general resemblance with Hyracotherium in the structure of its teeth, but differs from it by the form of the posterior molars, and by the absence of a free space between the incisors and the two first molars. The genus is not yet sufficiently characterized. The only species known attained to the size of the European hedgehog.

The genus *Hyops* is another American form, discovered in the same locality with Platygonus; that is, in the lead region of Illinois. It has been rather announced to the scientific world than described. It bears very close affinities with the peccaries, and is on that account interesting, as peccaries of our days are confined on the same continent to more southern localities.

The genus *Dicotyle* (the peccaries) is characterized by the upper canines directed straight upwards, and projecting very little out of the mouth. The hind feet are deprived of external toes; the tail is absent, and on the back a glandular opening is observed, from which a fetid secretion is exuded. The metatarsal and metacarpal bones of their two greater toes are soldered together like those of the ruminants, to which they seem also related in possessing a stomach divided into several sacs. This genus is peculiar to the American continent, from Arkansas to Brazil, more abundant as we proceed from the north of that limit towards the south. *D. torquatus* (the patira) or Mexican hog is the one met with in North America, as far north as Red River (Arkansas). Another (*D. albirostris* or *labiatus*), from Guiana, is represented on *pl.* 111, *fig.* 3. The peccaries seem to have been more abundant in South America during the tertiary epoch than in our days, as five species are said to have left their remains in the caverns of Brazil.

The genus *Sus* (the hogs) has twenty-four or twenty-eight molars or grinding teeth, of which the posterior are oblong with tuberculous crowns, and the anterior more or less compressed, and six incisors in each jaw. Each foot of the hog consists of two large middle toes armed with strong hoofs, and two much shorter lateral ones that hardly reach the ground. The incisors vary in number; the canines project from the mouth and curve upwards; the snout terminates by a sort of truncated button fitted for turning up the earth. The wild hog, *Sus scropha* (*pl.* 111, *fig.* 6), is the parent stock of our domestic hog, *Sus domesticus* (*pl.* 111, *fig.* 5), and its varieties. The color is generally black; the ears are straight. It is found all over the surface of the globe; its flesh is eaten by all except by Jews and Mahomedans. The eight following varieties are the most prominent ones. 1. *The Hungarian race* (Wallachia, Bosnia, and Moldavia), with very large ears and woolly bristles, greyish black, or yellowish red.

2. *The Champagne race*, very large too, body elongated, legs high, head and ears long, the latter pendent; hams proportionally small. 3. *The Bavarian race*, with delicate structure of the limbs and fine bristles, generally reddish brown spotted. 4. *The Poland race*, very large, yellowish, with a brown stripe along the back. 5. *The Westphalian race*, of a considerable size and very prolific. 6. *The ordinary German race*, not very large, white, grey, black, or spotted. 7. *The African race*, with a compressed body, straight ears, and remarkably thick and round hams. 8. *The Chinese hog*, which has been introduced into England and Germany: it is small, the dorsal line very much elongated, short limbs, a thick belly nearly reaching the ground, a short tail, and an almost naked body.

Fossil remains of hogs are found in America, Europe, and Asia; those of Europe belong to the genus Sus proper, those of Asia and America constitute the genera *Chœrotherium* and *Harlanus*. Of the genus Sus seven species are described, whilst others are still doubtful.

The genus *Harlanus* contains but one species, first described by Dr. Harlan under the name of *Sus americanus*, found in Georgia associated with bones of mastodonts, elephants, and megatherium. Remains of the same species have since been discovered in the lead region of Illinois. They resemble more *Porcus babyrussa* than any species of Sus.

The genus *Phacochœrus*, or wart-hogs, comprehends hogs of the actual fauna, having molars composed of cylinders cemented together by a kind of cortical substance, very similar to the transverse laminæ of those of the elephant, and also succeeding each other from behind. The head is very large; the tusks, like canines, are inclined laterally upwards, and of a remarkable magnitude. On each of their cheeks hangs down a thick fleshy lobe, rendering them very hideous. The species of this genus are mostly African; that from the Cape of Good Hope (*P. æthiopicus*) is represented on *pl.* 111, *fig.* 7.

The genus *Porcus* includes Asiatic living hogs known as *babiroussa* or *babyrussa* (*p.* 111, *fig.* 4), as the name has been latinized. They are slender and more elegantly constructed animals than the other members of the family. The canines are conical, and directed upwards and backwards, almost crescent-shaped. There are five molars above and five below on each side; four incisors to the upper jaw and six below. Fossil remains of this genus have been discovered in the Sivalic Mountains (Himalaya), showing once more that genera which have existed during the tertiary epoch and are perpetuated in ours, inhabit nearly the same spot as that upon which they were at first placed.

The genus *Chœrotherium* contains one extinct species of hog, from the upper tertiary of the Sivalic Mountains. It is a genus peculiar to that part of the world, and ceased to exist before the establishment of the present creation. It much resembled the hogs.

The genus *Calydonius*, from the tertiary beds of Switzerland, resembles somewhat Sus and Phacochœrus; the canines are provided with a rough and striated vertical band of enamel. Only two species are known.

FAM. 8. EQUIDÆ. With this family we close the series of pachyderms.

Nothing is more striking than the characters by which it is distinguished from all others, namely, a single hoof with an apparently single toe to each foot; but on the skeleton, on each side of the metatarsus and metacarpus, there are spurs representing two lateral toes. Only one genus of the present family is found in the actual fauna and with but comparatively few species, whilst in the tertiary deposits we find at least as many extinct species together with extinct genera.

The genus *Equus* is characterized by six incisors in each jaw, the crowns of which, at an early age, are marked with a fossula, and six molars throughout, with a square crown, marked by laminæ of enamel which dip into them, with four crescents, and in the upper ones, with a small disk on the inner edge. The male has also two small additional canines in the upper jaw, sometimes in both, which are almost always wanting in the female. Between these canines and the first molar is a free space corresponding to the angle of the lips where the bit is placed, and by which, as Cuvier remarks, man alone has been enabled to subdue and tame this powerful animal.

The common horse, *Equus caballus* (*pl.* 110, *fig.* 4), is the most important of all the animals that man has subdued. His associate in the chase, in war, and in the operations of agriculture, of arts and commerce, or raised for luxury, the horse has received by that perpetual contact a noble port and proud carriage. The horse, however, does not exist in a wild state at the present time, except in those places where horses were formerly domesticated and set at liberty, as in Tartary and America. They live in troops, each of which is conducted and defended by an old male. The young males are forcibly expelled as soon as they have reached the age of puberty, and follow the troop at a distance until they are joined by some of the younger mares. They propagate at four years; the period of gestation is eleven months. The age of horses is known by the incisors. The milk teeth begin to grow about fifteen days after the colt is foaled; at two years and a half the middle ones are replaced; at three and a half the two succeeding ones; at four and a half the outermost, or the *corners.* All these teeth, with an originally indented crown, gradually lose that mark by detrition. When seven or eight years old they are entirely effaced, and the horse is no longer marked. The life of the horse seldom extends beyond thirty years. This animal varies very much in size and color. The principal races exhibit sensible differences in the form of the head, in their proportions, and in their fitness for the various uses to which they are applied.

1. The most beautiful and swift is the *Arab* (of which *pl.* 110, *fig.* 6, represents the mare with her colt, and *fig.* 7 the stallion), which has been instrumental in mproving the *Spanish race*, and in connexion with the latter has contributed to form the *English race;* the Barbary, Persian, Circassian, and Turkish horses descend from the Arab. The Arab horse inhabits western Asia and northern Africa, where it is found of medium size.

2. The *northern horse*, rather small than large, light, docile, swift, hardworking, enduring, and satisfied with little and common food. The Tartar,

Russian, Polish, Lithuanian, and Swedish horses descend from the same stock, to which also belongs the Siberian horse (*pl.* 109, *fig.* 11), which during winter is covered with very thick and long hair.

3. The *West European horse* is large, less enduring, however, than either of the preceding ones; here belongs also the Spanish horse, the Sicilian, the French, English, Hungarian, Transylvanian, German, and Italian. *Pl.* 110, *fig.* 5, represents the *Norman team horse*, supposed to be of Danish breed. It is raised in lower Normandy.

The ass, *Equus asinus* (*pl.* 110, *fig.* 2), is another species of the same genus, originally from the great desert of central Asia, and still to be found there in a wild state, in innumerable troops, ranging from north to south, according to the season. The ass has been domestitated like the horse, and renders very great service to man, whom it has followed through almost all his migrations. A cross breed between the ass and the mare is called a mule, well known to the ancients, who called it *Mulus*, or the mule proper (*pl.* 110, *fig.* 3), produced by the male ass and female horse; whilst they termed *Hinnus* the mule arising from the union of the male horse with the female ass. Mules are very valuable animals, and capable of being employed where the horse and ass would be useless. The mule stock cannot perpetuate itself, for it soon degenerates when it is not sterile. At any rate, sterility declares itself after the second or third generation. To keep the stock perfect, the parent of both species, the horse and the ass, must always breed together.

The zebra, *Equus zebra* (*pl.* 110, *fig.* 1), originally from the south of Africa, has never been domesticated, and seldom tamed by man. It is nearly of the same form as the ass, but regularly marked with black and white transverse stripes. A female zebra has successively produced an offspring with the horse and the ass.

The dzigguetai (*Equus hemionus*), intermediate by its proportions between the horse and the ass, lives in troops in the sandy deserts of central Asia. It is of an isabella or light bay color, with a black mane and a dorsal line of the same color. Supposed to be the wild mule of the ancients.

The couagga and the onagga or dawn are two other wild species of horses.

If the American continent has no indigenous horse in the present fauna, the remains of several species are found in the tertiary deposits of North and another in South America. A few fossil species have been discovered in Europe and in the Sivalic Mountains in Asia. Two extinct genera of this family are already known.

The genus *Hippotherium* differs from Equus by the structure of the molars, the laminæ of which are much more complicated, forming numerous zigzag folds. It forms also a transition towards the pachyderms proper, inasmuch as the anterior feet possess the rudiments of a fourth finger or toe. Several species have been described as belonging to Europe, but more recent observations seem to reduce their number to one, which lived in numerous individuals in the centre and south of Europe during the meiocene period up to the diluvium.

The genus *Hipparion* closely resembles the horses, but was of a much smaller stature. Its remains were found in the south of France.

We have thus sketched out at some extent the history of the great group of pachyderms. The reasons for enumerating so many genera whose existence is confined to a past order of things, will appear when recapitulating the succession of the mammalia upon the surface of the earth. We have done this also with regard to Edentata, Marsupialia, and Cetacea. These groups are generally less known, and nevertheless of much greater importance, because they are the lowest of the class, and give us the key for its full understanding.

Group 4. *Ruminantia.*

We now proceed to the group *Ruminantia*, through which we may pass more rapidly, as the families of which it is composed are generally better known, most of them having representatives in the fauna of the present day. Several genera are found in North America, some of them of quite imposing stature, and inhabiting the sparsely populated portions of the country. Some belong to the prairies, some to the forests, and others to the mountains. The characters of the group consist essentially in the singular faculty of masticating their food a second time by bringing it back to the mouth after a first deglutition. This power depends upon the structure of their stomachs, of which they always have four, the three first being so disposed that the food may enter into either of them, the œsophagus terminating at the point of communication. The first, which is also the largest, is called the *paunch*, into which vegetable matters, coarsely bruised by a first mastication, are introduced. From the paunch they pass into the second, called the *honeycomb* or *bonnet*, from its peculiar structure, the walls being laminated like a honeycomb. This second stomach is comparatively very small, globular in form, and seizes the food, moistens, and compresses it into little pellets, which afterwards successively ascend to the mouth to be re-chewed. The animal remains at rest during this operation, which lasts until all the food first taken into the paunch has been submitted to it. The aliment thus re-masticated descends directly into the third stomach called the *leaflet*, on account of its walls being longitudinally laminated, or resembling the leaves of a book; and thence to the fourth or the *caillette*, the sides of which are wrinkled, and which is the true organ of digestion, analogous to the simple stomach of other animals. In the young, as long as they subsist on the milk of the mother, the caillette is the largest of the four stomachs. The paunch is only developed by the reception of larger and larger quantities of grass, which finally give it an enormous expansion.

The feet in ruminants are terminated by two toes, each cased in a hoof, which face each other by a flat surface, presenting the appearance of a single hoof which has been cleft; hence the name of cloven-footed, bifurcated, &c., applied to these animals. Behind the hoof are sometimes found

two small spurs, the vestiges of lateral toes. The two bones of the metatarsus and metacarpus are united into one called the *cannon*, but in certain species there are also vestiges of lateral metatarsal and metacarpal bones. The incisors are totally absent in the upper jaw, being only found in the lower one, and almost always eight in number. A callous pad is substitnted for them above. Between the incisors and molars is a vacant space, where, in some genera only, are found one or two canines. The molars, almost always six throughout, have their crowns marked with two double crescents, the convexity of which is turned inwards in the upper and outwards in the lower ones.

Of all mammals, the ruminants are the most useful to man. They furnish him with food; some serve him as beasts of burden; others with their milk, their leather, horns, tallow, &c. The tallow is produced by the fat, which in cooling down becomes brittle, a peculiarity that the fat of no other animal possesses.

The group of Ruminantia divides naturally into four families, the camels, giraffes, deer and antelopes, and oxen.

FAM. 1. CAMELIDÆ. The few members composing this family deviate a little from the ordinary ruminants, and show some slight affinity to the pachyderms. The number of molar teeth is smaller than usual; the first of these teeth is separated from the others by a large free space, and placed near the canine, which it resembles by its form, but generally falls off at an early age. In advance of the canine and in the upper jaw are found on each side an incisor, also resembling in its form that of the true canine, giving to the jaw the appearance of possessing three canines. In the lower jaw, the height of which reminds us of that of the horse, are only six incisors. Horns or other frontal processes are always wanting, as well as posterior claws or rudimentary toes. The hoofs are very small, situated near the extremity of the toe, and unable to support the body of the animal, which rests much more on a callous sole behind it. Of the two living genera composing this family, one is peculiar to the old, the other to the new world, both inhabiting the warm zone. The remains of an extinct genus have been found in Siberia.

The genus *Camelus* is characterized by the presence of canines in both jaws, and six molars above and five below on each side. The jaws themselves are slender, elongated, the nasal bones small; the posterior part of the skull is provided with very prominent crests and ridges; the temporal grooves are very deep. The lip is turned and cleft, the orbits prominent, the neck very long, the legs and feet disproportioned, giving to the camels a somewhat deformed appearance. The ease with which they are fed, and the faculty they possess of passing several days without drinking, make them of the highest importance for crossing the deserts. The inner wall of the paunch or first stomach is covered with large masses of cells, which retain for some time a certain quantity of water. Nothing of the kind is seen in other ruminants, although some pachyderms possess a similar provision. The camels have two toes united below nearly to the extremity by a common sole, and their back is furnished with lumps of fat.

They are large animals of the eastern continent, of which two species are known, both completely reduced to a domestic state in the hot regions of Africa and Asia. Wild camels are said to be found in central Asia.

The two humped camel, *C. bactrianus* (*pl.* 108, *fig.* 1), is originally from central Asia, and descends much less to the south than the dromedary or one humped camel, *C. dromedarius* (*fig.* 2), which has spread from Arabia into all the north of Africa, a great part of Syria, Persia, &c.

The remains of two fossil species of camels have been detected in Asia about the Sivalic Mountains. Others, but still doubtful, are from France, from the shores of the Red Sea, and South America, if the latter do not belong to the following genus.

The genus *Auchenia* differs from the preceding in being destitute of humps on the back. The legs are shorter than in the camel. The neck is long, more vertical. The ears and hoofs are long. The two toes are separated, or not united as in the camels by a callous sole. Five molars above and four below, on each side. The actual species of this genus belong to the western continent exclusively, where they represent the camels of the eastern. They are confined to the mountainous regions of South America. The lama, *A. lama* (*pl.* 109, *fig.* 6), the most common of the species, is as large as a stag, and was already known at the time of the conquest of Peru by Pizarro in 1534, and indeed was the only domesticated animal, being for the inhabitants of that country what the reindeer is to the Laplanders. The paco. *A. alpaca* (*pl.* 109, *fig.* 5), is a variety with long woolly hair. Another species, the vicunna, *A. vicunna* (*pl.* 109, *fig.* 7), is of the size of a sheep, covered with fawn-colored wool, extremely soft and fine, of which valuable stuffs are manufactured.

Two fossil species, one of the size of a horse, the other smaller, have been discovered in the caverns of South America.

The genus *Merycotherium* was established upon some molar teeth of the upper jaw, which, according to Cuvier, scarcely differs from the above genera. Only one species is known. Its remains were found in a fossil state in Siberia.

Fam. 2. Camelopardalidæ. Another eccentric type among ruminants, although not related so much to pachyderms as the camels are. This family contains but one single living genus, *Camelopardalis*, in which both sexes have conical horns, always covered with a hairy skin, and which are never shed. The lachrymal holes are wanting, as also the posterior hoofs and the canine teeth. It is one of the most remarkable forms in existence, from the length of its neck, the shortness of its body, and the disproportionate height of its fore legs. The back is much inclined. The only living species known is the giraffe, *C. girafa* (*pl.* 108, *fig.* 3), which is confined to the deserts of Africa. Its hairs are short and grey, sprinkled with fawn-colored angular spots, and a small fawn-colored mane. It is the tallest of all animals, its head being frequently elevated eighteen feet from the ground. Its disposition is gentle, and it feeds upon leaves.

Fossil remains of several species of this singular genus have been found

in the tertiary deposits of both Europe and Asia, showing a wider geographical range at an epoch previous to ours.

The genus *Sivatherium* is extinct, and belongs very likely to this family, although presenting some affinities with pachyderms. The upper molars are six in number. The only species known exhibits characters found only in ruminants. The heavier forms, shorter neck, and especially the probable existence of a proboscis, seemingly indicated by the form of the nasal bones, would refer it to pachyderms. It is one of the most remarkable and extraordinary fossils hitherto discovered in the Sivalic Mountains. The size of the head approaches that of the elephant, and hence we conclude that the species to which it belongs was nearly of the bulk of that proboscidian.

Another extinct genus is indicated, but not yet sufficiently known, which seems to be intermediate between Sivatherium and Camelopardalis proper, or the giraffe. A skull of this was found in the island of Perim in the Gulf of Cambay.

Fam. 3. Moschidæ. A very small family, represented in the actual fauna by a single genus, differing from the ordinary ruminants by the complete absence of horns in both sexes. The incisors as in the following are wanting above, and are eight in number below.

The genus *Moschus* is provided in the upper jaw with a long canine, directed downwards and backwards. The lachrymal holes are wanting, as in the giraffe; but there are posterior claws very much developed. The species inhabit the highest mountains from the Altai to Java. They are remarkably light and elegant animals. The most common species, the musk, *M. moschiferus* (*pl.* 108, *fig.* 4), celebrated for a well known, strong perfume, which it carries in a membranous pouch under the tail, and whose medicinal qualities are much esteemed, is of the size of a goat, has scarcely any tail, and is covered with hairs so coarse and brittle that they might be termed spines. Its habits are solitary and nocturnal; it is of an extreme timidity. The other species have no musk pouch, and are the smallest and most elegant of all the ruminants.

Fossil remains of several species were discovered in the middle and upper tertiary beds of Europe and Asia, but the European are not well determined.

The genus *Dremotherium* is known only in a fossil state, the fragments of which were found in the fresh water tertiary strata of Auvergne (France), differing from Moschus in the absence of the canine teeth. Among these numerous remains there seem to be several species, two of which have already been described.

In the following ruminants, in the male at least, there are two horns; that is to say, prominences of the frontal bones, which are not found in any other family of mammals.

In some, these prominences are covered with an elastic sheath, composed as it were of agglutinated hairs, which increase by layers during life. The substance of this sheath is the horn, properly so called, and the sheath itself

a hollow horn (*cavicornia*). The bony prominence which it envelopes, and which grows with it, never falls, and remains permanently through life. Such are the horns of oxen, sheep, goats, and antelopes.

In others, the bony prominences are covered for a time with a hairy skin, similar to that of the rest of the head, but have at their base a ring of bony tubercles, which, as they enlarge, obliterate the vessels which carry the fluid to that skin. The latter becomes dry, and is cast off, the bony prominences being left bare, and after a certain period separate from the cranium to which they were attached; they fall off, and the animal remains for a time defenceless. They are reproduced, and generally larger than before, and again destined to undergo the same fate. Such horns, purely osseous, and subject to periodical changes, are styled *antlers*. Stags, deer, &c., bear antlers. We have referred to this subject in the introduction to the present article (p. 393).

Fam. 4. Cervidæ. Very numerous in species, and containing ruminants with a slender stature, a short tail, and an elegant body, possessing eight incisors in the lower jaw, and none at all in the upper one; the feet are bisulcated, but the posterior toes are not always developed, and in that case the antlers are also absent. The antlers consist of a solid bony mass, branching off several times, and differently, according to the genera. Often it is the male alone which is provided with these appendages; but in a few species they are developed in both sexes. These animals are exceedingly fleet, live commonly in the forests, and feed on leaves, buds, grasses, &c. The genera contain generally numerous species, distributed over the whole world. Fossil remains of this family are found in profusion in the meiocene deposits.

The genus *Cervus* (the deer) exhibits constantly horns in the male, branched, subpalmated, or simple, rounded at their root. The ears are large; there are no canine teeth at all; the tail is short and bushy. The American species of this genus are the following:

1. The common or American deer (*C. virginianus*) is reddish or bluish-grey, according to the season. The young are spotted with white. The horns are moderate, curving forwards, with the concave part turned in front, provided with from one to six points, occasionally palmated.

2. The black-tailed deer (*C. macrotis*) is greyish, with a black-tipped tail, large ears, and horns with three branches; the forehead is dark-brown. This species is larger than the common deer (*C. virginianus*), and inhabits the plains of Missouri.

3. The long-tailed deer (*C. leucurus*) is reddish-brown in summer, light-grey in winter. The tail is long, white beneath and at the tip. It is smaller than the common deer, and inhabits the Rocky Mountains. It resembles most the roebuck of Europe (*C. capreolus*), represented on *pl.* 107, *fig.* 4, which lives in couples and inhabits the high mountains of the temperate part of Europe. The flesh is held in much better esteem than that of the common deer.

Cervus richardsonii is a species nearly like the black-tailed deer, and inhabiting the plains of the Columbia.

Fossil remains of deer have been found in both Europe and Asia, in such proportions as to induce the supposition that species were more numerous during the tertiary epoch than in our days. More than forty species are already named, and others not yet determined. Two species have been signalized in the caverns of South America. There can be no doubt that some of them belong to the other genera of the family, and some others will constitute new ones, when they shall be better known; for of a good many we as yet possess but a fragment of the horns or of the teeth. The genus *Dicrocera* has already been proposed for the oldest species of the meiocene of France; and the genus *Megaceros* for the gigantic fossil Irish deer, the whole skeleton of which is known.

The genus *Dorcatherium* differs from the deer in having seven molars above and seven below, whilst the usual number is six in each side of both jaws. Two species are described, one from Germany, the other from France, both from the upper tertiary beds.

The genus *Palæomeryx* is characterized by a different folding of the enamelled plate of the teeth. Five extinct species have already been referred to it.

The genus *Alces* (the moose) is characterized by having the points of the horns united into one blade or palm, more or less indented. The tail very short. The moose (*A. lobatus*) belongs to this genus, the largest of all the species of the cervine family. It is of the size of a horse, of a blackish-grey, the adult male provided with broad flattened horns. The snout is long and prehensile; the neck provided with a mane. Inhabits the American continent. The European elk or eland, *Cervus alces* (*pl.* 109, *fig.* 10), was formerly thought not to differ from it. A closer comparison has shown that they are distinct.

The genus *Elaphus* (the stags) is provided with horns in the male only, which are round, very large, and rarely palmated. Canine teeth exist in the upper jaw of the male; the snout terminates by a distinct muzzle. The American stag or elk (*E. canadensis*) is one fourth larger than the European stag or red deer (*pl.* 107, *figs.* 1 and 2), and nearly of the same color. The antlers are equally rounded, but more developed, and mostly without a palm. Inhabits the temperate part of North America. The remains of a fossil stag have been found in the United States, and a similar one in Europe, for which the genus *Strongyloceros* has been proposed.

The genus *Tarandus* (reindeer) is characterized by the presence of horns and canine teeth in both sexes. The horns themselves are smooth and palmated; the muzzle is small; the tail short; the ears moderate. The reindeer or cariboo of North America (*T. hastalis*) is a different species from the European, *T. furcifer* (*pl.* 109, *figs.* 8 and 9). The latter, it is well known, inhabits Lapland, where it is domesticated by the Laplanders, who have numerous herds of them, which, during the summer, they lead to the mountains, and in winter bring back to the plains. They are their only beasts of burden and draught; their flesh and milk serve them for food, their skin for clothing, &c.

The American cariboo is found abundantly in North America, its southern limit falling in the State of Maine.

The European fallow deer, *Cervus dama*, is represented on *pl.* 107, *fig.* 3.

FAMS. 5 AND 6. CAVICORNIA, OR ANTILOPIDÆ AND BOVIDÆ. These families are characterized by hollow horns, having always developed posterior toes and seldom canine teeth. The dentition is very similar to that of the preceding family. The members of this family are distributed over the whole surface of the globe, and some of them are the most excellent domestic animals.

The genus *Antilope* is the most numerous in species of the whole group of ruminants. In the general form of their body the antelopes resemble the deer and elk; they are slender and swift, inhabiting rather the warm than the cold zone. They have been greatly subdivided into sections, subgenera, or genera, according to the various authors. 1. The horns may be annulated, with a double curvature directed forwards, inwards, or upwards, and then we have the type of the gazelle, *A. dorcas* (*pl.* 108, *fig.* 5), which inhabits North Africa, and lives in large herds, which form a circle when attacked, presenting their horns at all points. The soft expression of its eyes furnished numerous images to the Arabian poets. 2. Sometimes the horns are annulated, and curved three times, such as in the antelope of India and Nubia. 3. The horns may be annulated and curved only twice, but winding in an opposite direction to those of the preceding ones, the points directed backwards; the genus *Damalis*, of some writers. 4. The horns are small, straight, or but slightly curved, shorter than the head, and in the greater number found only on the male. The *A. pygmæus* belongs to this section. 5. The horns may be annulated, with a simple curve, the point directed forwards, as in the section of *Reduncæ; A. redunca*, from Senegal (*pl.* 108, *fig.* 6). 6. The horns may be straight, or but slightly curved, and longer than the head, as in *Oryx.* 7. The horns may be annulated, with a simple curve, the points directed backwards, as is the case in the blue and the equine antelope from Senegal. 8. The horns may be encircled with a spiral ridge, as in the elk of the Cape of Good Hope, which is as large as the largest horse, living in troops in the mountains north of the cape. The *A. scripta* or *maculata* (*pl.* 109, *fig.* 4) belongs to this section. 9. The horns may be bifurcate, as in the genus *Antilocapra*, of all the forms of hollow horns the most singular. In the male the horns are forked, compressed, their extremities turned backwards; the female has no horns. The lachrymal holes are absent. The tail is very short. The best known species is *A. americana*, which inhabits the vast prairies of the middle and western parts of North America, where it roams in large herds. The tine of the horns is about the middle of the height. 10. There may be four horns, as in the genus *Tetracera*, inhabiting the forests of Hindostan. 11. There may be two smooth horns in the male only, short and bent forwards, as in a species from India, *A. picta*.

The fossil species of *Antilope* are far from being as numerous as in the actual fauna, and their number, although small, might be reduced by a more complete study of the remains, as some of them show a great resemblance

to those of the goats and sheep. These remains are found in the middle tertiary beds in Europe and Asia, and what is still more remarkable is to find them in the caverns of Brazil, where the genus does not exist in our days.

The genus *Leptotherium* is completely extinct, and lived in Brazil during the epoch of the diluvium. Two species are known already; the structure of their skeleton is slender and graceful like that of the deer to which they come nearest, and from which they, however, differ as well as from all other ruminants.

The genus *Rupicapra* has the form of the common goat; both sexes are provided with horns, straight, suddenly bent backwards like a hook. The limbs are strong. Behind the horns are two glandular openings. The hairs are long; of the under-wool there is but a little. *R. tragus*, the chamois (*pl.* 109, *fig.* 3), inhabits the highest mountains of Europe. The swiftness of its course among rocks and precipices is wonderful; it is seen in small herds in the middle region. The number of individuals, however, is decreasing every year, for, although they are difficult to hunt, the inhabitants expose themselves to the greatest dangers for the sake of killing some of them.

The genus *Catoblepas* contains but one species, the gnou or gnu, a very singular being, which, at first glance, seems to be a monster composed of parts of different animals. It has the body and croup of a small horse, covered with brown hairs; the tail is furnished with long white hairs, like that of the horse, and on the neck a straight mane, the hairs of which are white at the base and black at the tip. The horns are approximated and enlarged at the base like those of the Cape buffalo; they descend outwardly, and turn up at the point; its snout is large, flat, and surrounded by a circle of projecting hairs; under the throat and dewlap is another black mane; the feet have all the lightness of the stag's. Horns exist in both sexes. This animal inhabits the mountains north of the Cape of Good Hope, where it is rather rare. The ancients appear to have had some knowledge of it.

The genus *Capra* (the goats) is provided in both sexes with horns directed upwards and backwards; the chin generally furnished with a long beard. The wild goat (*C. œgagrus*) appears to be the stock of all our domesticated varieties of goats. It lives in herds in the mountains of Persia, and perhaps in those of other countries, even in the Swiss Alps. The oriental bezoar is a concretion found in its intestines. The domesticated species of goat which has been introduced into America, *C. hircus* or *œgagrus* (*pl.* 107, *fig.* 10), varies infinitely in size, color, and in the length and fineness of the hairs; in the size of the horns, and even in their number. The Angora goats have the longest and most silky hair. Those of Thibet are renowned for the admirable fine wool which grows among their hair, and out of which the celebrated Cashmere shawls are manufactured. All these animals are stout, capricious, and fond of wandering. Sensible of their mountain origin, they prefer dry and wild places, feeding on coarse grass and shoots of young trees. They do much injury to the forests. The kid only is eaten, but their milk is useful and applied medi-

cinally in several diseases. The period of gestation of the female is five months, and she generally has two kids at a birth.

The genus *Ovis* (the sheep) differs very slightly from the preceding except by the external covering, which in the sheep is generally wool throughout. The horns are directed backwards, and then inclined spirally more or less forwards. There is no beard under the chin. The goats and sheep produce together a prolific offspring, showing a very intimate relationship between these two animals. As in the goats, there are several wild races or species very nearly allied. The argali of Siberia (*O. ammon*) and the moufflon of Sardinia (*O. musimon*) appear to differ from each other only in size. Both are supposed to be the original stocks from which are descended the innumerable races of our woolly animals which vary so greatly. *Ovis aries* or *domesticus* (*pl.* 107. *fig.* 9). The wool may be coarse or fine, the animal itself large or small, provided with horns of various size, which are either wanting in the female or present in both sexes. The most interesting sheep are those of Spain, which have a fine curled fleece, with large spiral horns on the male; it is now more diffused through Europe than formerly. The English variety has a long and fine wool. The most common variety in the south of Russia has a very long tail. Those of India and Guinea, which also have a long tail, are distinguished by their long legs, very convex foreheads, pendent ears, no horns, and short hair. Those of Syria and Barbary have a long tail loaded with an immense mass of fatty substance. In the race of Tartary and China the tail is transformed into a double globe of fat. The ears are pendent, the horns of the male large, those of the females moderate, and the wool mixed with hair. Sheep are valuable for their flesh, suet, milk, skin, and wool; when well managed, flocks of them are everywhere the source of wealth. The period of gestation lasts five months. Usually two lambs are produced at a birth.

The Rocky Mountain sheep (*O. montana*) is a species nearly allied to the argali, and inhabiting the mountain range west of the Mississippi. It is strikingly characterized by the immense size of the horns.

Fossil species of goats and sheep have been discovered in the caverns of the greatest part of Europe, and referred either to the genus *Capra* or *Ovis*, the generic difference being so slight as not to allow of much discrimination in fragmentary skeletons.

The genus *Bos* (the oxen) is characterized by the lateral direction of the horns, existing generally on both sexes, then inclined upwards or forwards, constituting a crescent. The oxen are large animals, with a broad snout, short and thick body, and stout legs. The different species of oxen in their wild state are distributed as follows:—In the temperate part of North America, the buffalo, *Bos*, or *Bison americanus* (*pl.* 109, *fig.* 1). The horns are black, and very thick near the head, whence they curve upwards and outwards, rapidly tapering towards their point. The physiognomy of the bison is menacing and ferocious. Its hairs are more shaggy in winter than in summer. It lives in herds of innumerable individuals in the country west of the Missouri.

Formerly its range was much more extensive, overspreading most of the United States. It is, however, probable that the bison did not occur east of Hudson River and Lake Champlain, and perhaps in no point on the immediate Atlantic coast.

The common ox, *Bos taurus* (*pl.* 107, *figs.* 7 and 8), is supposed to be derived from a stock now extinct, and which formerly inhabited Europe, and only found now in a fossil state. How far this is the case it is impossible to say. In the numberless varieties the horns have very different directions, and are of very different sizes, sometimes even totally wanting. The common races of the torrid zone have all a lump of fat upon their shoulders, and some of them are not larger than the hog.

The ure-ox (*Bos urus*), which formerly inhabited all the temperate parts of Europe, but has now taken refuge in the great marshy forests of Lithuania and the Caucasus, where it is become so exceedingly rare, that in order to prevent its complete destruction and disappearance from among living animals, the penalty of death is threatened to all who may kill one of them. It has been generally considered, and perhaps very erroneously, as the wild stock of our domestic horned cattle.

Another species is *Bos bubalus* (*pl.* 109, *fig.* 2), originally confined to India, and brought into Egypt and Greece during the middle ages. This animal is subdued with great difficulty, being extremely powerful; it prefers marshy grounds, and feeds upon coarse plants which the common ox would refuse. Its flesh is not esteemed. In the mountainous districts of the northwest of India there is a domestic race, which very likely is descended from this species.

A third species is the yak (*B. grunniens*), originally from the mountains of Thibet, and now very widely spread in Turkey. It is a small species, the tail of which is completely covered with long hairs like that of the horse, and provided with a long mane on the back.

A very large species, of an excessively ferocious disposition, inhabits the woods of Caffraria, the Cape buffalo (*B. caffer*), provided with very large horns directed outwards and downwards, ascending from the point, flattened, and so wide at their base that they nearly cover the forehead, leaving merely a triangular space between them.

The oxen made their first appearance in Europe towards the end of the tertiary epoch, and seem to have been quite numerous, for their remains are found in almost all the caverns and sandy deposits. Two species are described as peculiar to the State of Kentucky (*B. bombifrons* and *B. latifrons*). A fragment of the head of an ox was found near one of the tributaries of the Orange river (Africa); several species are indicated in the Sivalic Mountains and other parts of the Asiatic continent, showing a distribution similar in both the tertiary and modern eras.

The genus *Ovibos* contains but one species, the musk ox of North America (*O. moschatus*). The horns are approximated and similarly directed, but meet on the forehead in a straight line; those of the female are smaller and more widely separated; the end of the snout is furnished with hairs. It stands low, and is covered with tufted hair that reaches to

the ground. The body is covered with a coat of long, dense hairs. The tail is extremely short. Musk oxen are found in the greatest numbers within the Arctic circle; considerable herds are occasionally seen near the coast of Hudson's Bay. The horns of the musk ox are employed for various purposes by the Indians and Esquimaux, especially for making cups and spoons. From the long hairs growing on the neck and chest, the Esquimaux make a kind of wig drooping down to the shoulders, to defend their faces from troublesome insects.

A fossil species (*B. pallasii*), which seems to be related to the musk ox, has been discovered in the States of Kentucky and Missouri, and we are told also, in Siberia. Whether these remains are perfectly identical is still to be ascertained.

Group 5. *Rodentia.*

The group of *Rodentia* includes those herbivorous mammals whose jaws are provided in front with long, curved, and cylindrical or nearly cylindrical teeth, the exposed ends of which are bevelled off on the inner surface, so that they terminate in a sharp, cutting edge. These teeth, two in number in each jaw, and sometimes four in the upper, are separated by a wide empty space from the molars, and thus cannot seize a living prey, nor tear any flesh; they cannot even cut the food, but serve to file, and by continued action they reduce it into separate molecules; in a word, they *gnaw:* hence the term *Rodentia* or *gnawers.* The molars have a flat crown, whose enamelled eminences are always transverse, and studded with blunt and but little elevated tubercles. When these eminences are simple lines, and the crown is very flat, the genera are more exclusively frugivorous; when the eminences are divided into blunt tubercles, they are omnivorous. The condyle of the lower jaw is longitudinal or rounded, and inclosed in the glenoid cavity in such a manner as to permit very little lateral motion to the jaw, which, however, moves freely in the longitudinal direction. This group, one of the most clearly defined, has representatives in all parts of the world, the species of which are very numerous, feeding upon vegetable substances, and generally of small size, a few exceeding the common rabbit in bulk. The form of the body is generally such that the hinder parts of it exceed those of the front, so that they rather leap than walk. In some of them this disproportion is even as excessive as it is in the kangaroo.

FAM. 1. LEPORIDÆ. The hare family is less numerous in species than other families of rodents, and offers many exceptions to the general or normal characters of the order. The large size of the openings in the skull, combined with the very imperfect condition of the palate; the perforations in the nasal process of the superior maxillary bone; large orbits meeting in the mesial line of the cranium; the small temporal fossæ; and the increased number of incisors and molar teeth, are among the more striking characters presented by the skull. The extra pair of incisors in the upper jaw is

small, and placed behind the principal pair, and these latter are grooved in front. The upper incisors are double; both the upper and under ones are shorter, that is, less deeply implanted in the jaw than in other rodents, and they are always white. The molar teeth are always rootless, five above and five below, or six above and five below, on both sides of the jaws.

Only two living genera compose this family; a third is extinct.

The genus *Lagomys* has no visible tail, short and rounded ears, short hind legs, and the molars twenty in number, five above and five below on each side. The species are generally of small size. One is American (*L. princeps*), and inhabits the Rocky Mountains. Other species occur in Siberia and Central Asia, as *L. alpinus* (*pl.* 113, *fig.* 2 *b*). The pikas, as the Lagomys are commonly called, although found in considerable number, are not, strictly speaking, gregarious; they occur only in alpine or sub-alpine districts, where they form burrows in the ground, or sometimes take shelter amongst the loose stones. Occasionally, when the weather is cloudy, they will quit these retreats in quest of food during the day, but the night is their ordinary time of feeding. Their food consists of various kinds of grass, and as in the high and cold regions which they inhabit the herbage is covered with snow during the winter months, their instincts lead them to lay up a stock for this season. Large quantities of dried grass and other vegetable matters are collected by the pikas for their winter's consumption; these they pile up in the autumn, like small haystacks, which gradually disappear as the spring approaches, unless, as not unfrequently happens, these stores are robbed by the sable hunters to feed their horses. The species of this genus seem to have been more numerous during the tertiary epoch than in our days, and inhabited the southern part of Europe. Some of the species have been made the type of the genus *Anœma* of some German palæontologists.

The genus *Titanomys* is extinct, of which several fragments of jaws with prismatical teeth have been found in Germany. The upper molars are provided only at the inner side with a very superficial furrow, and the under ones, especially the posterior, exhibit characters wanting in Lagomys. Only one species is known.

The genus *Lepus* (the hares and rabbits) is characterized by the presence of six molars above and only five below. The ears are large and elongated, sometimes longer than the head itself; the tail short and very bushy; the hind legs powerful and much longer than the fore legs. Under this genus come both the hares and rabbits, for no structural difference as yet has been discovered between them; the rabbits burrow, whilst the hares make a kind of nest, called a *form*, on the surface of the ground, on which they lie. The young of the rabbits, at least such is the case in the common kind, are blind and naked when born; those of the hares are clothed with hair and have the eyes open. By far the greater number of the species of this genus agree with the hare in the habits noticed, and that animal may therefore be regarded as the type of the genus. Destitute of means of defence, the hares are timid, have remarkable power of flight, and to warn them of danger, their senses of hearing, seeing, and smelling are usually

highly developed. The eyes are very large and prominent, and being placed laterally, enable the animal to see in all directions, or nearly so, at the same time. The common hare of Europe (*L. timidus*) is figured in *pl.* 107, *fig.* 5, whilst *fig.* 6 represents the rabbit or cony (*L. cuniculus*). North America has many species: the polar hare (*L. glacialis*), inhabiting the northernmost part of the continent, its southern limit being 62° north latitude. The American hare (*L. americanus*), found about Hudson's Bay, Canada, Newfoundland, all the New England States, and in the northern portions of New York, Pennsylvania, and Ohio; confined to the eastern portion of the continent. The swamp hare (*L. aquaticus*), from Alabama, Mississippi, lower part of Louisiana, and even Texas. The wood hare (*L. sylvaticus*), or common grey rabbit, is found almost throughout the United States. The marsh hare (*L. palustris*) inhabits the southern and western parts of the United States. The Nuttall's hare (*L. nuttalli*) is originally from the west side of the Rocky Mountains, in the neighborhood of the Columbia and Shoshonee rivers. The Bachman's hare (*L. bachmani*) inhabits the south-west portion of North America. The wormwood hare (*L. artemisiæ*) is from the Rocky Mountains. The prairie hare (*L. townsendi*) is found on both sides of the Rocky Mountains in the region of the Columbia River, and ranges eastwards on the Missouri, beyond the Yellowstone River. The Californian hare (*L. californicus*) inhabits California, in the open hilly country which surrounds the harbor of San Diego. The Texan hare (*L. texianus*). The Mexican hare (*L. nigri-caudatus*) in Mexico and adjoining parts of California.

In South America there is but one species of hare hitherto noticed. The remains of a fossil species were discovered in the caverns of Brazil, which resemble very closely the species now living in the same country. The hares were numerous in Europe during the epoch of the diluvium, and resemble also very closely the actual species inhabiting the ancient continent.

FAM. 2. HYSTRICIDÆ. The hystricine rodents have four molar teeth above and four below, rooted or rootless, and the terminal portion of the snout clothed with short hairs. This family may be divided into six sub-families.

Sub-fam. 1. *Caviina* have rootless molar teeth divided by folds of enamel, so as to form lobes having acute angles; the series of molars on opposite sides of the upper jaw converging, and nearly meeting in front. The incisor teeth are comparatively short, those of the lower jaw not being extended backwards as far as the springing of the angular portion, or descending ramus. There are four toes to the fore feet and three to the hind. The tail is wanting, or rudimentary; the upper lip entire. The clavicles are wanting.

The genus *Dolichotis* comprehends the cavies provided with long limbs; ears fully half as long as the head, pointed, broad at the base, and deeply emarginated behind; the tail is very short, and recurved. The Patagonian cavy is the only species contained in this genus.

The genus *Cavia* (cavies) is composed of species provided with short

limbs, and with ears likewise short. The feet are naked beneath; the molar teeth nearly of equal size, each molar with two principal lobes. To this genus belongs the domesticated Guinea pig, *Cavia cobaya* (*pl.* 113, *fig.* 2 *a*); it inhabits the banks of the Rio de la Plata, and extends northwards into Paraguay, Bolivia, and Brazil.

Fossil species of this genus were found in the caverns of Brazil; it is interesting to know that another species existed in Europe during the tertiary epoch.

Some species of cavies are grouped under the sub-generic name of *Cerodon* or *Kerodon*, to which three South American species are referred, from the diluvial period.

The genus *Hydrochœrus* includes cavies with the upper incisor teeth having a broad and shallow groove in front; the molars unequal in size; the feet short and broad, and semi-palmated, the toes terminating in broad and depressed nails; the ears small. The capybara (*H. capybara*) is the only living species known; a second, but fossil and extinct, has been discovered in the caverns of Brazil.

Sub-fam. 2. *Chinchillina* (*Lagostomidæ* of some authors, both names being indifferently used) are those hystricines with rootless molar teeth, having parallel, or nearly parallel transverse plates of enamel; the series of molars on either side of each jaw converging in front; the tail is long or of moderate length, recurved and bushy; clavicles perfect and slender. They inhabit the mountains of Peru and Chili, and one species occurs in the plains of La Plata.

The genus *Lagostomus* is composed of but one species (the viscacha), that which inhabits the plains of La Plata. It is burrowing in its habits, easily distinguished from the other Chinchillina by the reduced number of the toes, three in number, to its hind feet, and the comparatively long, compressed, and sharply pointed nails, with which they are provided. The fore feet have four toes, armed with rather short, arched, and pointed nails. The upper lip has a vertical groove; the snout is broad and expanded. A fossil species of this genus occurs in the Brazilian caverns.

The genus *Lagidium* is characterized by long ears, a tail long and bushy, the tarsi entirely naked beneath, with four toes to the fore feet, the nails of the toes short. Two species belong to this section.

The genus *Chinchilla* differs from the preceding only in being provided with large and rounded ears, five toes to the fore feet and four behind. The name of *Eriomys* is sometimes given to this genus; *Eriomys laniger*, or *Chinchilla lanigera* (*pl.* 113, *fig.* 1). As belonging to this group, and more particularly related to Lagostomus, we must insert here the genus *Megamys*, one of the largest known, although extinct, rodents. It contains but one species, from Patagonia.

Sub-fam. 3. *Octodontina* are hystricines with rootless molar teeth, having but a single indenting fold of enamel on either side, or rarely with an extra fold on the inner side of the molars of the lower jaw; zygomatic arch with an angular process on the lower edge; the hind feet provided with five toes; the fore feet likewise with five toes, or sometimes with four. The

species of this section inhabit the middle and southern parts of South America, on both sides of the Andes.

In the genus *Habrocoma* the fore feet possess four toes; the ears are very large. The species, two in number, inhabit Chili.

The genus *Octodon* has moderately large ears; a tail as long as the body, slightly bushy at the extremity; five toes to the fore and hind feet; the claws small. The species inhabit Chili.

The genus *Schizodon*, again, has moderate sized ears, a tail shorter than the body, clothed throughout with small adpressed hairs; the fore feet strong; the claws about equal to the toes in length; five toes throughout; incisor teeth stout. The species inhabit the eastern side of the Southern Andes.

The genus *Spalacopus* is characterized by having rudimentary ears, almost entirely hidden by the fur of the head; the tail is short, and clothed with short hairs; the nails of the toes of the fore feet rather shorter than the toes; the incisor teeth are moderately broad, those of the upper jaw distinctly directed forwards as well as downwards. Inhabit Chili, and live almost entirely under ground.

In the genus *Ctenomys* the ears are also rudimentary, but the eyes are small, the tail short, the fore feet large and powerful, and armed with nails which exceed the toes in length; the incisor teeth are very broad, the upper pair distinctly convex in front, the lower pair flat at the same part; molars with two unequal lobes. Extends from westwards of Brazil into Bolivia, and southwards to the Straits of Magellan. The species, four in number, live under ground. Two fossil species of this genus have been discovered in South America, at Bahia Bianca and Monte Hermoso.

Sub-fam. 4. *Echimyina*, have complicated molar teeth, and generally rooted; the hind and fore feet provided with five toes.

The genus *Capromys* still possess rootless molar teeth; each upper molar has a single deep fold of enamel on the inner side, and two deep folds on the outer; the upper lip is slightly cleft; the ears are moderate; the tail of moderate length, and somewhat sparingly clothed with hairs, which do not hide the scaly skin; the feet are naked beneath, and covered with small tubercles; the nails of the toes are large, and much curved; the pupil of the eye is vertical. There are two species of this genus known, and they both inhabit the island of Cuba. One of them, *C. pilorides*, is the type of the genus *Isodon* of Say; this species is seen in the forests, climbing the trees with great activity, both for safety when danger threatens, and to seek its food, which not only consists of fruits and the leaves and bark of trees, but likewise of the flesh of animals, especially of the lizard of the genus Anolius, which it hunts with great preseverance. It is readily tamed.

The genus *Archæomys* had a species in Europe during the upper tertiary period, very nearly approximated to Capromys, and representing evidently at that time, on the Old Continent, that latter genus now confined to the West Indies. The name *Gergoviamys* is applied to the same genus.

The genera *Plagiodontia*, *Myopotamus*, *Cercomys*, *Petromys*, *Dactylomys*,

Loncheres, *Isothrix*, *Mesomys*, *Echimys*, *Nelomys*, and *Aulacodon*, belong to this section of hystricines.

Several fossil remains of this sub-family have been found in the caverns of Brazil, and which were described as species of Aulacodon, Nelomys, and Echimys; but the characters by which these genera are distinguished being so difficult to trace out upon fragmentary remains, the genus *Carterodon* has been proposed, to unite them all. Besides, there is another species referred to the genus *Loncheres*, and still another to the genus *Phyllomys*, and a third, *Lonchophorus*, has been established. Its affinities place it between Echimys and Loncheres, and it existed only during the period of the diluvium.

Sub-fam. 5. *Dasyproctina*, are characterized among the other hystricines by semi-rooted molar teeth, arranged in parallel series. The feet are constructed for running, with five toes, or three only to the hind feet, terminated by sub-solid nails, which are but little arched. The tail is rudimentary; the body clothed with hair only, there being no admixture of spines. This sub-family includes two living genera.

The genus *Cœlogenys* contains but one well established species, the Paca. The zygomatic arch is very well developed and of great depth, the incisors slender, and five toes to the fore and hind feet. The *Osteopera platycephala*, of Harlan, is referred to this species. Fossil remains of one or more species of the present genus have been discovered in the Brazilian caverns.

The genus *Dasyprocta* (aguti) has but three toes to the hind feet; the limbs are long and slender; the crown of the molar teeth rounded with a single fold of enamel, and four or five isolated grooves surrounded by enamel. The hinder parts of the back are covered with very long and coarse hairs. Several species of this genus are known in the actual fauna; the fossil remains of others are found in the Brazilian caverns.

Sub-fam. 6. *Hystricina* proper, or porcupines, are provided with rooted or semi-rooted molar teeth; the feet are short, the number of toes variable, and the body more or less armed with spines.

The porcupines are divided into two sections. One is composed of species living upon the ground and seeking shelter in burrows which they themselves form. They have five toes both to the fore and hind feet; the soles of the feet naked and smooth; the molar teeth semi-rooted and arranged in parallel series. The species of this section (*Philogœæ*) are confined to the old world. Those of the other section (*Philodendræ*) are peculiar to the new world. They have climbing habits, and live almost entirely in trees. Their feet are usually provided with but four toes, and these are nearly equal in length, armed with long, compressed, and curved claws; sometimes, however, the hind feet have five toes. The soles of the feet are thickly studded with minute, depressed warts.

The porcupines of the new world, the *Philodendræ*, are divided into three genera, *Chætomys*, *Cercolabes*, and *Erethizon*. The first contains but one species, from Brazil; the second is more numerous, and is more widely spread. One of the species, *C. villosus* (*pl.* 113, *fig.* 3 *a*), inhabits

Brazil. Finally, the third genus, characterized by a thick, short, and depressed tail, covered above at the base with hairs and spines; at the apex, and on the under surface, with stiff bristles. The feet short and broad; four toes to the fore and five to the hind feet, armed with long and curved claws. To this genus belongs the Canada porcupine (*Erethizon dorsatus*), which inhabits North America. That from the western coast (California, Unalaschka, Sitka) has been described as a distinct species, but there are still doubts entertained whether it is really distinct or not. Two fossil species of this section are found in Brazil.

The porcupines of the old world form two genera. The genus *Hystrix* includes the common porcupine of Europe, *H. cristatus* (*pl.* 113, *fig.* 4), together with other species from different regions of Asia. The genus *Atherura*, with its tail nearly as long as the body, contains two species, one from Africa, the other from southern Asia.

Remains of the porcupine have been found in the centre of Europe, and about the Sivalic Mountains in Asia, but not yet characterized.

The fresh water tertiary deposits of France have yielded other remains which seem more intimately related to the new world porcupine than to those of the old, and for which the genus *Theridomys* was proposed to include temporarily one species.

Fam. 3. Muridæ. This is the largest family of the rodents, and is composed of animals of moderate size; indeed, some of the smallest of the class belong to it. The cutting teeth, two in each jaw, are awl-shaped in the lower; the molars are simple or compound, the upper shelving backwards, the lower forwards; the limbs are proportionate; the tail scaly; fur, with scattered long hairs. The family may conveniently be subdivided into eight sub-families.

Sub-fam. 1. *Saccomyina*, is a somewhat doubtful or excentrical group, as far as known at present, its affinities with the other sub-families having not yet been made out fully. The animals which compose it, known as sand and mole rats, are provided with cheek pouches which open externally, four molar teeth, sometimes rootless and sometimes rooted. The tail, short in some, is long in others.

Here are referred the following genera:—*Dipodomys*, *Macrocolus*, *Heteromys*, *Saccomys*, *Perognathus*, and *Geomys*.

The genus *Geomys* comprehends the largest number of species which constitute the sub-family, and chiefly North American. The Columbia sand rat (*G. douglasii*) is one of them. Its body is shaped like that of the mole, and covered with soft, dense, velvety fur, of a uniform brown color. It has large cheek pouches hanging down the sides of the head, the latter being large and depressed, the nose obtuse, particularly when viewed in profile. The tail is more than half the length of the body, round, tapering, and obtuse, covered with hairs, particularly near its base. The legs are short and thick. The claws are very sharp pointed, compressed, curved, and about as long as their respective toes. The palm is naked, and its posterior part is filled by a large, rounded, callous eminence. The hind feet are a little more slender than the fore ones, and they are armed with

smaller claws, shaped like those of the Spermophiles. The hind soles are entirely naked, without any conspicuous tubercles; the heel is naked and narrow.

"These little sand rats," says Dr. Richardson, "are numerous in the neighborhood of Fort Vancouver, where they inhabit the declivities of low hills, and burrow in the sandy soil. They feed on acorns, nuts (*Corylus rostrata*), and grass, and commit great havoc in the potato fields adjoining the fort, not only by eating the potatoes on the spot, but by carrying off large quantities of them in their pouches."

The genus *Saccomys* is founded upon a North American Geomys. The genus *Perognathus* was created for a new species inhabiting the upper Missouri. The genus *Heteromys* contains two species; one inhabits Central America, the other Colombia and Guiana. The genera *Macrocolus* and *Dipodomys* are Mexican, and include each only one species. *Dipodomys phillipsii* is the well known jumping or kangaroo rat of California.

Sub-fam. 2. *Bathyergina*, composed only of the genera *Bathyergus* and *Georychus*, the first with one, the second with two species, all three from southern Africa. The *Bathyergus capensis* burrows in the sand flats of the Cape of Good Hope in very great numbers. In every part of these flats mole-hills are observed, and when walking on the surface the foot often sinks into their galleries, thus making it very dangerous to ride on horseback in those localities, owing to the danger of being thrown by the unexpected sinking of the horse's feet into these holes.

Sub-fam. 3. *Arvicolina*, have, like the rats (*Murina*), three molars above and below on each side, but rootless, each one being composed of triangular prisms, placed on two alternate lines.

The genus *Arvicola* includes the common field-rats, which have a hairy cylindrical tail, shorter than the body, and the ears clothed with hair. The fore feet have four toes and a rudimentary thumb; the hind feet are five-toed, furnished with weak nails. They burrow in the earth and feed on grain, bulbous roots, and grasses; some are omnivorous, they do not climb, are not dormant in winter, but seek their food during cold weather, eating roots, grasses, and the bark of trees.

The species of this genus are found all over the world; nine of them belong to North America. The meadow mouse or campagnol (*A. pennsylvanica*) is very abundant in the northern and eastern United States, and extends northwards as far as Hudson's Bay, and westwards to the banks of the Ohio. It swims and dives well. A dozen more species are found in North America; some inhabit the Eastern States, others belong to the western territories, Texas, Oregon, California, &c.

The genus *Lemmus* (the lemmings) includes those Arvicolina which have very short ears and tails, and the toes of the fore feet adapted for digging. There are five distinct nails to the fore feet. The species of this genus are peculiar to the northern hemisphere. One of them, of the size of a large rat, is celebrated for its occasional migrations in innumerable bodies. At these periods they are said to march in a straight line, regard-

less of rivers or mountains; and while no obstacle can impede their progress, they devastate the country through which they pass. Their usual residence appears to be the shores of the Arctic Ocean. Two species of this genus are found in North America.

The lemming of Hudson's Bay has become the type of the genus *Myodes*, which differs slightly from the genus Lemmus. Its specific name is *M. hudsonius.* The two middle toes of the fore feet seem to have double claws, which is owing to the skin at the end of the toe being callous and projecting from under the nail. Of the size of the rat, and lives under the ground.

The genus *Fiber* contains but one species, peculiar to North America, the musk-rat (*F. zibethicus*). The lower incisors (two in number as above) are sharp-pointed and convex in front; the molars, three on each side, above and below, have a flat crown furnished with scaly transverse zigzag laminæ. The fore feet have four toes with the rudiment of a thumb, and the hind feet five, the edge furnished with stiff hairs, which assist the animal in swimming, the hind toes semi-palmated. The tail is long, compressed, granular, nearly naked, having a few scattered hairs. A gland near the origin of the tail secretes a white, musky, and somewhat offensive fluid. The musk-rats are nocturnal in their habits, consequently their manners and customs are difficult to observe. In winter they construct a hut on the ice, in which several of them reside together. "A pond," say Audubon and Bachman, "supplied chiefly, if not entirely, by springs, and surrounded by low and marshy ground, is preferred by the musk-rats; they seem to be aware that the spring-water it contains probably will not be solidly frozen, and there they prepare to pass the winter. Such a place, as you may well imagine, cannot, without great difficulty, be approached until its boggy and treacherous foundation has been congealed by the hard frost, and the water is frozen over; before this time the musk-rats collect coarse grasses and mud, with which, together with sticks, twigs, leaves, and anything in the vicinity that will serve their purpose, they raise their little houses from two to four feet above the water, the entrance being always from below. We have frequently opened these nests, and found in the centre a dry, comfortable bed of grass, sufficiently large to accommodate several of them. When the ponds are frozen over, and a slight fall of snow covers the ground, these edifices resemble small haycocks. There is another peculiarity that, it appears to us, indicates a greater degree of intelligence in the musk-rat than we are usually disposed to award to it. The animal seems to know that the ice will cover the pond in winter, and that if it has no places to which it can resort to breathe, it will be suffocated. Hence you here and there see what are called breathing-places. These are covered over with mud on the sides, with some loose grass in the centre, to preserve them from being too easily frozen over. We have occasionally seen these winter huts of the musk-rat, in the vicinity of their snug summer retreats in some neighboring river's bank, and have sometimes been half inclined to suppose that, for some cause or other, they gave a preference to this kind of residence. We are not, however, aware that these nests are made use of by the musk-rat in spring, for the purpose of rearing its young. We

believe these animals always for that purpose resort to holes in the sides of ponds, sluggish streams, or dykes."

The arvicoline Muridæ were present in the tertiary fauna. Several species of *Arvicola* or *Hypudæus* are mentioned and described from continental Europe.

The genus *Stenofiber*, referred to the arvicolines by some and to beavers by others, has been established upon a skull found in the middle tertiary beds of Auvergne. Its forms are intermediate between the beaver and the musk-rat.

Sub-fam. 4. *Spalacina*, of which there are no representatives in North America, is a small group composed of but thirteen species, distributed into seven genera, as follows: *Rhizomys*, six species, Asiatic and African; *Tachyoryctes* and *Heterocephalus*, each one species, both African; *Ellobius*, two species, European and Asiatic; *Ommatostergus* and *Spalax*, each one species, both in France; and *Siphneus*, one species, in Siberia.

The genus *Spalax* (the rat-moles) has very short legs, each foot provided with five toes and as many flat and slender nails. The tail is very short or completely wanting, and the same observation applies to the external ear. They live under ground like the moles, raising up the earth like them, although provided with much inferior means for dividing it; but they subsist on roots only. The blind rat-mole (*S. typhius*) is a very singular animal, which, from its large head, angular on the sides, its short legs, and total absence of a tail and of any appendage externally, has the most shapeless physiognomy. In the opinion of some writers, this should be the animal alluded to by the ancients, when they spoke of the mole as being perfectly blind.

Sub-fam. 5. *Murina*, has a greater number of representatives in the old than in the new world. The genera into which they are distributed amount to not less than twenty-eight to thirty, and the species to more than two hundred. There are comparatively very few in North America, where the genera *Mus*, with eight species; *Neotoma*, with two; and *Sigmodon* and *Hesperomys*, with only one, in all twelve species, represent Murina.

The Asiatic and African mice and rats are distributed into the genera *Isomys*, *Akomys*, *Golunda*, *Vandeleuria*, *Nesokia*, *Dendromys*, *Pithecheir*, *Cricetomys*, *Phlœomys*, *Psammomys*, *Malacothrix*, *Euryotis*, *Mystromys*. The genera *Hapalotis* and *Hydromys* are Australian. In South America we find forty-five species of *Hesperomys*, the genera *Oxymycterus*, *Calomys*, *Akodon*, *Drymomys*, and *Reithrodon*, with a few only. The European species belong to the genera *Sminthus*, *Gerbillus*, and *Cricetus*, which have also representatives in Asia and northern Africa.

The genus *Mus* (rats and mice) is distributed throughout the whole surface of the globe. It is characterized by three molars on each side above and below, the anterior of which is the largest; its crown is divided into blunt tubercles, which, by being worn, give it the shape of a disk, sloped in various directions; the tail is long and scaly. The ears oblong or round, nearly naked. The common mouse, *Mus musculus* (*pl.* 113, *fig.* 8), originally from the East, has been introduced into America with the white

race, as well as the black rat, *M. rattus* (*pl.* 113, *fig.* 7), which has the same origin. The latter is now replaced by the Norway or brown rat (*M. decumanus*), which did not appear in Europe until the eighteenth century, and has now become more abundant than the black rat. It has also reached America in the same manner as the two preceding species. Besides these three introduced species America possesses several others (five are well ascertained) which are peculiar to her. The field mouse of France, *M. sylvaticus* (*pl.* 113, *fig.* 6), is never found to reside in the houses.

The genus *Gerbillus* (the gerbils) has three molars that differ very little from those of rats. Their superior incisors are furrowed with a groove. Their hind feet are somewhat longer in proportion than those of rats in general. The tail is long and hairy.

In the genus *Cricetus* (hamsters) the teeth also differ very slightly from those of rats, but the tail is short and hairy, and on each side of their mouth internally are sacs or cheek pouches in which they transport the grains they collect to their subterranean abodes, accumulating large heaps. Most of the species of this genus inhabit the northern parts of Europe. *Pl.* 113, *fig.* 9, represents the common hamster (*C. vulgaris*).

The genus *Sigmodon* has three molars above and below on each side, provided with small roots, and very profound, alternate folds towards the summit. The tail is hairy, the feet simple, the fore feet four-toed with the rudiment of a fifth; the hind feet five-toed. Two species of this genus exist in North America; one is *S. hispidum* or the cotton rat from Florida, very numerous in the deserted plantations lying on the River St. John, particularly in the gardens. Its burrows are seen in every direction.

The genus *Neotoma* embraces two North American species. The grinding surfaces of the molar teeth differ somewhat in this genus from what they are in *Arvicola*, and their large roots constitute a very essential character. The fore feet are provided with four toes and the rudiment of a fifth; the hind ones are five-toed. The tail is hairy.

The Florida rats (*N. floridana*) in Florida burrow under stones and the ruins of dilapidated buildings. In Georgia and South Carolina they prefer remaining in the woods. In some swampy situations, in the vicinity of sluggish streams, amid tangled vines interspersed with leaves and long moss, they gather a heap of dry sticks, which they pile up into a conical shape, and which, with grasses, mud, and dead leaves, mixed in by the wind and rain, form, as they proceed, a structure impervious to rain, and inaccessible to the wild cat, racoon, or fox. At other times their nest, composed of somewhat lighter materials, is placed in the fork of a tree. Another species (*N. drummondii*) has been discovered in the Rocky Mountains.

A third species has recently been detected in Rockland county, New York, by John G. Bell, Esq., but not characterized. Numerous remains of an extinct species, the largest of the genus, are found in the bone caves of Pennsylvania.

The Murina were represented in the fauna of the tertiary epoch by species belonging to the genera *Mus* (rats) and *Cricetus* (hamsters), and were very abundant during the diluvial period, at least in Europe.

Sub-fam. 6. *Ctenodactylina*, is the smallest section among Muridæ, there being only one species known, and therefore constituting one genus, the genus *Ctenodactylus* (the hairy-footed jerboa), belonging to Barbary, in northern Africa. The head is more compressed than in any of its congeners. There are only three toes to the hind feet, as in the jerboa (Dipus), but they are more hairy.

Sub-fam. 7. *Dipodina*, are those murines in which the hind legs are much longer than the fore ones, the consequence of which is that they jump instead of run on the ground. In general appearance they have some resemblance to the kangaroos. The species are distributed into four genera, three of which belong to the old hemisphere and one to North America. The latter is the genus *Meriones*, with but one species, *M. americanus* (the jumping mouse). The upper incisors are grooved, and a very small tooth is observed in advance of the upper molars. The tail is very long and nearly naked. A very active animal, that shuts itself up in its burrow and passes the winter in a state of lethargy.

In the genus *Dipus* (jerboas) the tail is long and tufted at its extremity; the head is large; the eyes also are large and prominent. The ancients called these animals the biped rats, from the enormous disproportion of their posterior limbs. They seldom move otherwise than by great leaps on their hind feet. There are five toes to each of the fore feet, and in certain species, besides the three great toes to the hind feet, there are small lateral ones. They live in burrows, and become torpid during the winter. Six species are contained in this genus, all of them inhabiting the old hemisphere.

The genus *Alactaga* contains eight species also inhabiting the old hemisphere. They are distinguished from the jerboas (Dipus) by much longer ears. They also possess two small lateral toes.

The genus *Pedetes* has a large and flattish head, a thick snout, and long ears. The anterior limbs have five toes armed with very long claws; the posterior legs, very long, have but four toes. The tail is long and bushy. The molars are simple, four above and four below on each side. A single species, *P. capensis* or *Helamys caffer* (*pl.* 113, *fig.* 5), is known from the Cape of Good Hope.

A fossil species of Dipodina (*Dipus dipoides*) has been discovered in central Europe.

Sub-fam. 8. *Myoxina*, are excluded from the new world. The genus *Myoxus* or dormice, characterized by the presence of four molars above and below on each side; a very long tail, sometimes well clothed with hair and round, sometimes depressed, and sometimes tufted at the extremity only. The fur is very soft and fine. There are five toes behind, four and the vestiges of a fifth in front. Dormice are pretty little animals with lively eyes, living on trees like squirrels, and feed on fruits. They become torpid in winter. This genus is composed of ten species, seventeen of

which are European, two Asiatic, and five African. *Pl.* 113, *fig.* 10, represents *Myoxus glis*, or fat dormouse of Europe.

The genus *Graphiurus* is entirely African, and contains only two species from the south and interior of that continent. The molars are remarkable for their small size; the tail is short, very fleshy. All the toes are armed with pointed, compressed, arched, and strong claws. The limbs themselves short, delicate, and not differing much from each other in length.

Two or three fossil species referred to the genus *Myoxus* have left their remains in the tertiary beds of Europe.

FAM. 4. CASTORIDÆ, is composed of only one living genus (*Castor*), beavers.

The genus *Castor* (the beaver) has very strong incisors, those of the lower jaw a little smaller. In the upper jaw the molars, four in number, differ slightly from each other in size, and have one internal and three external grooves; whilst in the lower one, where four also is the number, there are three grooves on the inner side, and one on the external. The eyes are small; the ears short and round. Each foot possesses five toes; those of the fore feet are short and close, whilst on the hind feet they are long and palmated. The tail is large, horizontally flat, and scaly. Near the base of the tail exists a pouch which secretes an unctuous matter. Only two species are known to belong to this genus, one in Europe and another in America, *C. fiber americanus* (*pl.* 114, *fig.* 1), which, however, resemble each other so closely that they have been pronounced identical by many naturalists.

The beavers are larger than the badger, and of all quadrupeds the most industrious in constructing a common dwelling. They choose water of such a depth as is not likely to be frozen to the bottom, and as far as possible a running stream, in order that the wood which they cut above may be carried downwards by the current to the spot where it is to be used. They keep the water at an equal height, by dams composed of branches of trees, mixed with clay and stone, the strength of which is annually increased, and which finally, by the progress of vegetation, becomes converted into a hedge. Each hut serves for two or three families, and consists of two stories: the upper is dry for the residence of the animals, and the lower, under water, for their stores of bark. The latter alone is open, and the entrance is under water, having no communication with the land. The huts are a kind of rude wickerwork, being made of interwoven branches and twigs of trees plastered with mud. There are always several burrows along the bank, in which they seek for shelter when their huts are attacked. They only reside in these habitations during the winter; in the summer they separate, and live solitary. The beavers may be easily tamed, and accustomed to feed on animal matters.

Several species of the genus Castor proper have been found in a fossil state in the tertiary deposits of the old hemisphere. Some of them have been considered as new generic types, and form the genera *Chalicomys* and *Trogontherium*, which are not universally admitted as differing sufficiently from the genus Castor.

An animal nearly allied to the beaver existed in North America during the tertiary epoch, but far surpassing in bulk those of the present time. Its remains were discovered in the State of Ohio, and described under the name of *Castoroides ohioënsis.* Its life was probably aquatic, and its food consisted of vegetable substances, which it gnawed off with its powerful incisors.

The genus *Palæomys* has been admitted as an extinct genus of the old world, and has left the remains of one species (*P. castoroides*) in the tertiary deposits of Germany. Its dentition comes near that of the beavers, but sufficiently different in some peculiarities of structure to permit the establishment of a new genus.

Fam. 5. Sciuridæ. The characters of this family consist in having simple molars with tuberculous crowns, five above and four below on each side; the lower incisors very much compressed. The toes are long, armed with sharp claws, four on the anterior and five on the posterior feet; the anterior thumb is very short. The tail is long and tufted. Some are provided with cheek pouches. In others the skin of the sides is extended between the anterior and posterior limbs. We distinguish three kinds of squirrels: the true squirrels, the ground squirrels, and the flying squirrels.

The genus *Pteromys* (flying squirrels) is easily distinguished from any other of the same family by the expansion of the skin between the hind and fore legs, by means of which they are enabled to support themselves for a moment in the air, and to make very great leaps. The American flying squirrel, *Pteromys volucella* (*pl.* 113, *figs.* 12 and 13). An analogous species is found in Poland, Russia, and Siberia. Besides, there are three more species in North America inhabiting the north and west. There is one found in the Indian Archipelago that is nearly of the size of a cat.

The genus *Pseudostoma* possesses four prismatic molars above and below and on each side, the first of which is double, the others simple. The upper incisors are furrowed with a double groove in front. There are five toes to each foot. They have very short legs and very deep pouches which open externally, enlarging the sides of the head and neck. Four species are known to exist in North America. One is the Canada hamster or pouched rat (*P. bursarius*), which inhabits deep burrows. Another is from Hudson's Bay, and receives the common appellation of mole-shaped sand rat (*P. talpoidea*). A third species is found in the northern regions, and the fourth in Florida.

The genus *Aplodontia* is destitute of cheek pouches. Its body is thick and short, clothed with fur like that of the musk-rat, but neither so long nor so fine. The head is flat and broad; the nose a little arched, thick, and obtuse. There are five molars above and four below on each side. The limbs are robust and short, the feet moderately strong, with naked soles, all provided with five toes, rather short, but well separated. The thumb of the fore feet, however, is much shorter than the other toes. The claws, particularly the anterior ones, are very long, strong, much compressed, and but little curved. The tail is very short, and concealed by the fur of the hips. These animals form small societies, live in burrows, and feed, as

usual, on vegetable substances. One species only is described, and belongs to the northwest portion of North America, the sewellel of Lewis and Clark (*A. leporina*). A second species is indicated, if the characters alluded to by the author are not differences occurring in the young.

The genus *Arctomys* (the marmots) has, like the squirrels, five molars above and four below, all of them bristled with points; accordingly some species are inclined to eat flesh and feed upon insects as well as grass. As to their general form, the marmots are the very reverse of the squirrels, being heavy, provided with short legs, a middle-sized or short hairy tail, and a large, flat head, passing the winter in a state of torpor and shut up in deep holes, the entrance of which they close with a heap of grass. They live in societies, and are easily tamed. The alpine marmot, *A. marmotta* or *alpinus* (*pl.* 113, *fig.* 11), is about the size of the hare. Four species are described from North America, among which is the common Maryland marmot, or ground-hog (*A. monax*) of the northern, eastern, and middle states.

The genus *Spermophilus* possesses cheek pouches, two incisors above and below, and five molars above and four below, exactly as in the ground squirrels; but whilst the external appearance of the latter is more like that of squirrel proper (*Sciurus*), the general appearance of Spermophilus is more that of the marmots, from which it is distinguished by the dentition. The molars are more narrow transversely than longitudinally. The ears are generally short. The feet are of moderate length, adapted for walking on the ground; the nails are inferior in size to those of the marmots, and less hooked than those of the squirrels. There are four toes to the fore feet, with the rudiment of a thumb protected by a blunt nail; the hind feet have five toes. The tail is always shorter than the body. The form of the body is rather slender, and possesses a degree of lightness and agility approaching the activity of the squirrels. Twelve species of this genus are known to exist in North America, three in Europe, and a few in Asia and Africa, if some of the latter are not to be referred to the genus Arctomys.

In North America they are commonly known by the names of marmot squirrels, prairie marmot or prairie dog, tawny American marmot, leopard marmot, small grey squirrel (Lewis and Clark), and other similar appellations more or less arbitrary. They chiefly inhabit the northern regions. The following is an extract from Say, in Long's Expedition to the Rocky Mountains, on the habits of the prairie dog (*S. ludovicianus*):

"This interesting and sprightly little animal has received the name of prairie dog, from a fancied resemblance of its warning cry to the hurried barking of a small dog. The sound may be imitated by the pronunciation of the syllable 'chek, chek, chek!' in a sibillated manner, and in rapid succession, by propelling the breath between the tip of the tongue and the roof of the mouth. As particular places are in general occupied by the burrows of these animals, such assemblages of dwellings are denominated *prairie dog villages* by the hunters. They vary widely in extent, some being confined to an area of a few miles, others bounded by a circumference of many miles. Only one of these villages occurred between the

Missouri and the prairie towns; thence to the Platte they were much more numerous. The entrance to the burrow is at the summit of the little mound of earth brought up by the animal during the process of the excavation below. These mounds are sometimes inconspicuous, but generally somewhat elevated above the common surface, though rarely to the height of eighteen inches. Their form is that of a truncated cone, on a base of two or three feet, perforated by a comparatively large hole or entrance at the summit or in the side. The whole surface, but more particularly the summit, is trodden down and compacted, like a well worn pathway. The hole descends, vertically, to the depth of one or two feet, whence it continues in an oblique direction downwards. A single burrow may have many occupants. We have seen seven or eight individuals sitting upon one mound. The burrows occur usually at intervals of about twenty feet. They delight to sport about the entrance of their burrows in pleasant weather. At the approach of danger they retreat to their dens, or when its proximity is not too immediate, they remain, barking and flourishing their tails, on the edge of their holes, or sitting erect to reconnoitre. When fired upon in this situation, they never fail to escape, or, if killed, to fall into their burrows, where they are beyond the reach of the hunter. As they pass the winter in a lethargic sleep, they lay up no provision of food for that season, but defend themselves from its rigors by accurately closing up the entrance of the burrow. The further arrangements which the prairie dog makes for his comfort and security are well worthy of attention. He constructs for himself a very neat globular cell with fine dry grass, having an aperture at the top large enough to admit the finger, and so compactly formed, that it might almost be rolled over the floor without injury."

The genus *Tamias* (the ground squirrels) is very nearly allied to the squirrels proper (Sciurus), from which it differs by many particulars, among which is the presence of ample cheek-pouches, a longer head, the ears placed further back, a more slender body, and shorter extremities. The ears themselves are rounded, and without any tufts on the edge or behind them. The tail is shorter than the body, rounded, narrow, seldom turned up. There are four toes to the fore feet, with a minute blunt nail in place of a thumb, and five to the hind ones. The claws are hooked. Two incisors above and two below, smooth, the lower ones compressed and sharp. The molars are five above and four below on each side, short, and the crown tuberculous. The species are all of small size, and longitudinally striped on the back and sides. They do not mount trees unless driven thither by necessity, but dig burrows, and spend their nights and the season of winter under the ground.

Several species of this genus exist in North America; one is known in South America, and another in the northern portions of the eastern continent. The chipping squirrel or hackee (*Tamias lysteri*) is found from the northern lakes (Huron and Superior) all along the eastern, northern, and middle states and range of Alleghany Mountains.

The genus *Sciurus* is characterized by an elongated body; a long tail,

furnished with hair; a large head, with erect ears; projecting and brilliant eyes; the upper lip divided. There are four toes before, with a tubercle covered by a blunt nail, and five behind; four molars on each side, above and below, variously tuberculated; a very small additional molar is seen in front and above, permanent in some species, but drops out in most cases when the young have attained the age of six to twelve weeks; the fingers are long, slender, and deeply cleft; the nails very acute, and greatly compressed. We quote the following description of the habits of the squirrels from Audubon and Bachman, Quadrupeds, p. 38:

"Squirrels are able to leap from branch to branch, and from tree to tree, clinging to the smallest twig, and seldom missing their hold. When this happens to be the case, these animals have an instinctive habit of grasping, in the descent, at the first object which may present itself; or, if about to fall to the earth, they spread themselves out in the manner of the flying squirrels, and thus, by presenting a greater resistance to the air, are enabled to reach the ground without injury, and, recovering instantaneously, they ascend the nearest tree.

"All the American species of this genus, as far as we have been able to become acquainted with their habits, build their nests either in the fork of a tree, or on some secure portion of its branches. The nest is hemispherical in shape, and is composed of sticks, leaves, the bark of trees, and various kinds of mosses and lichens. In the vicinity of these nests, however, they have a still more secure retreat in some hollow tree, to which they retire in cold or in very wet weather, and where their first litter of young is generally produced.

"Several species of squirrels collect and hide away food during the abundant season of autumn, to serve as a winter store. This hoard is composed of various kinds of walnuts and hickory nuts, chestnuts, chinquepins, acorns, corn, &c., which may be found in their vicinity. The species, however, that inhabit the southern portion of the United States, where the ground is seldom covered with snow, and where they can always derive a precarious support from the seeds, insects, and worms, which they scratch up among the leaves, &c., are less provident in this respect; and of all these species, the chickaree, or Hudson Bay squirrel (*S. hudsonius*), is by far the most industrious, and lays up the greatest quantity of food.

"In the spring, the squirrels shed their hair, which is replaced by a thinner and less furry coat; during summer, their tails are narrower and less feathery than in autumn, when they either receive an entirely new coat, or a very great accession of fur; at this season, also, the outer surfaces of the ears are more thickly and prominently clothed with fur than in the spring and summer.

"Squirrels are notorious depredators of Indian corn fields of the farmers, in some portions of the country consuming great quantities of this grain, and, by tearing off the husks, exposing an immense number of the unripe ears to the mouldering influence of the dew and rain."

Twenty species of this genus inhabit North America. The common or red squirrel (*S. hudsonius*) has a great geographical range, and extends

very far north; is found again in Labrador, Newfoundland, and Canada; it is most common, however, in the New England States, and even occasionally in the hilly portions of New Jersey and Pennsylvania. The Carolina grey squirrel, *S. carolinensis* (*pl.* 113, *fig.* 14), is most abundant in Florida, Georgia, and South Carolina; the other species live in different districts of the country. The common squirrel of Europe (*S. vulgaris*) is figured on *pl.* 107, *fig.* 11.

Among the fossil remains of Sciuridæ hitherto discovered in the tertiary deposits of Europe, species belonging to the genera Sciurus, Arctomys, and Spermophilus, were recognised. They resembled very much the existing species.

Order 5. Insectivora.

This is a small order, and composed also chiefly of small animals, the largest having but twice the bulk of the common rat. They all possess molar teeth studded with conical points; their principal food consists of insects. They lead a nocturnal or subterranean life, and in cold climates many of them pass the winter in a torpid state. Their feet are short and their motion feeble; in walking they all place the whole sole of the foot on the gound.

Insectivora may be divided into three families: *Talpidæ*, or moles; *Soricidæ*, or shrews; and *Erinaceidæ*, or hedgehogs. The latter has no representatives in North America.

Among the fossil remains of Insectivora hitherto known there is a fragment of a lower jaw from the fresh water strata of Wordwell, England, whose affinities with either one of the families constituting this order have not yet been ascertained. The genus *Spalacodon* has been proposed for it.

Fam. 1. Talpidæ. The body, rather thick and plump, is covered with hair throughout; the limbs are short, the anterior ones terminating by a rounded hand provided with five toes as well as the hind feet. The eyes are so minute as to escape notice, whence the assertion that moles are blind. The fact is that the eyes are in a very rudimentary or undeveloped condition. The animals of this family are subterranean, and appear but very seldom on the surface.

The genus *Chrysochloris* (or golden mole) has, like the Mygale, two incisors above and four below. The molars are long, distinct, and almost all shaped in triangular prisms. The snout is short, broad, and recurved. There are only three nails to the fore feet; the external one, very large, curved and pointed, serves as a powerful instrument for excavating and piercing the earth.

The genus *Talpa* (mole proper) has very feeble jaws, the food consisting of worms and insects. There are six incisors above and eight below. The canines have two roots, partaking of the nature of the false molar; the false molars themselves are four in number above and three below, backwards of which are three bristled or true molars. The common mole

of Europe, *Talpa europæa* (*pl.* 113, *fig.* 17), is a very troublesome animal in orchards, gardens, and cultivated lands generally. It was once supposed to exist in North America, but this is now known not to be the case. Three well ascertained species of moles have been discovered in a fossil state in the tertiary beds of Europe. The moles are replaced in North America by the two following genera.

The genus *Scalops* is strictly North American, and has a long head terminated by an extended, cartilaginous, flexible, and pointed snout; the eyes and ears are concealed by the hair, and very minute. The hind feet are short and slender, with five toes, and delicate hooked nails; the fore feet or hands are broad, their claws long and flat, fitted, as in the mole, for excavating the earth. The common American shrewmole (*S. aquaticus*) is an example of this genus. It is spread over a wide area of the United States from Canada to Florida, and westwards as far as Kentucky. Three or four species more are known.

The genus *Condylura*, also North American, is characterized by certain cutaneous filaments which surround the nostrils and give to the nose a star-like appearance, whence the name of star-nosed mole. The only species of the genus hitherto known is *C. cristata*. In their feet and their general appearance they resemble the mole, but their tail is longer.

This family existed in North America during the tertiary epoch, and it is highly probable that species belonging to the above genera will some day be discovered.

The genus *Anomodon* rests upon a canine tooth which possesses a general resemblance to those of Scalops, but indicates an animal of a much larger size. The tooth itself is much more compressed than in any of the genera of the same family. The remains of the only species were found in the lead region of Illinois together with some pachyderms, of which we have already spoken.

In Europe is found the genus *Dimylus*, with one species from the tertiary beds of Wirtemberg, known by a lower jaw in which only two molars are left, possessing a double row of tubercles; whilst in the genus Talpa, to which it comes nearer, these tubercles form three rows.

Fam. 2. Soricidæ. This family is composed generally of very small animals, whose body is covered with hair, with the general appearance of the mice, from which they greatly differ in their dentition. The tail is more or less elongated, the body itself disproportionately slender; the limbs short; the snout more or less pointed. They live under the ground, come seldom to the light, and are provided with very minute eyes. Some possess glands emitting peculiar odors.

The genus *Sorex* (the shrews) is distinguished from the others of the family by having under the skin, and upon each flank, a small band of stiff thickly set setæ, between which, in the rutting season particularly, peculiar glands secrete an odorous fluid. The two upper middle incisors are hooked, and dentated at their base, the lower ones slanted and elongated; on each side, five above and two below, are small false molars, and three bristled or true molars throughout. The shrews live in holes, which they excavate in

the earth, and which they seldom leave till evening; they feed on worms and insects. Of this genus North America possesses many species, inhabiting different districts.

The shrews are found also in Asia, Europe, and Africa, and are more numerous towards the tropical parts; the countries where they most abound are tropical Africa, central and tropical Asia. They constitute particular genera in Asia, such as *Hylogale*, *Hylomys*, &c.

The extinct genus *Oxygomphius* had a great resemblance to *Hylogale javanica*, and differs from it in the tubercular structure of the molar teeth. Two species were found in the tertiary deposits of Wirtemberg.

Several species of Sorex have left their remains on the continent of Europe.

The genus *Mygale* (the desmans) is peculiar to Europe; it differs from that of the shrews in having two very small teeth placed between the two great lower incisors, and the two upper incisors flattened and triangular. There are six or seven false molars, and four bristled ones; the snout is prolonged into a flexible proboscis; the external ear is short and not conspicuous; the tail long, scaly, and laterally compressed; there are five unguiculated toes to each foot, united by a membrane; the eyes are very small. A species is very common in Southern Russia, along the rivers and lakes, where it feeds on worms, larvæ of insects, and particularly on leeches. Its burrows, which are constructed in the bank, commence under water, and ascend to such a height as to be above its level in the greatest flood. Another, but smaller, inhabits the Pyrenees. Of this genus, remains of two fossil species have been discovered in France.

The genus *Palæospalax* is extinct, and known only by a fragment of the lower jaw, with six teeth in their natural position, which in their structure are intermediate between Mygale and Talpa. A single species was discovered on the coast of Norfolk (England).

The genus *Macroscelides* is characterized by a narrow snout, ending anteriorly in a long and sub-cylindrical proboscis, having the nostrils at its apex; the eyes are moderate; the ears large and round; the body furry; the tail elongated and scaly, annulated, and furnished scantily with hairs; the feet are five-toed; there are two incisors above and two below, and five true molars; between these and the incisors are, above and below, four teeth, which have been called canines, three of which are probably false molars.

The five known species of this genus belong to tropical Africa; the *M. typicus* inhabits the open country in the interior of South Africa, and is occasionally seen during the day about the roots of bushes or among brushwood, whence, upon being discovered, it instantly retreats to its natural and subterraneous habitation.

FAM. 3. ERINACEIDÆ. The body is generally covered with spines instead of hairs, sometimes with spines and setæ intermingled. This family includes the largest species of the order; they live in woods and hedges, sometimes in burrows. Although chiefly nocturnal in their habits, they often come to the light. The eyes are perfectly developed. Some present the remarkable phenomenon of a lethargic sleep under the tropical zone.

This family, as far as our knowledge extends, existed during the tertiary epoch, under the same generic form as in our days. Several species of the genus *Erinaceus*, and one of the genus *Centetes*, have been found in Europe; none yet in America, where the living types are also absent.

The genus *Erinaceus* (hedgehog) has its body covered with spines instead of hairs, showing thus a resemblance to the porcupine. The skin of the back is furnished with powerful muscles, by which, when the head and the feet are brought towards the abdomen, the animal can shut itself up, presenting to its enemies spines all around. The tail is very short, and there are five toes to each foot; there are six incisors in each jaw, the middle ones being the longest; on each side three false molars, three true molars bristled with points, and a small one studded with tubercles.

The common hedgehog, *E. europæus* (*pl.* 113, *fig.* 18), is common in the woods and hedges, and also in houses. It passes the winter in its burrow. Its skin, it is said, was formerly used to dress hemp.

The genus *Centetes* (tenrecs) is composed of four species, inhabiting tropical Africa and the Island of Madagascar. Their body is covered with spines, like the hedgehog, but much shorter; and the animals do not possess the faculty of rolling themselves so completely into a ball. The tail is absent; the snout is sometimes elongated, always much pointed; there are four or six incisors, and two great canines in each jaw; there are one or two false molars, and four true ones, triangular and bristled; each foot has five distinct toes, armed with crooked spines. They are nocturnal animals, passing three months in the year in a state of lethargy, although inhabiting the torrid zone. We are even told that it is during the greatest heat that they grow torpid.

The Oriental or Asiatic hedgehog constitutes the genus *Gymnura*.

Order 6. Cheiroptera.

This order is composed of the animals commonly known as bats, and easily distinguished from all other mammals by a membranous expansion which extends from the sides of the neck between the fore limbs and toes down to the tip of the tail, and which enables them not only to sustain themselves in the air, but also to move through it in any direction they may desire. They thus possess the power of true flight as in birds, with which indeed they are frequently confounded. The bones of which the anterior extremities are composed are very much elongated, especially those of the fingers, and constitute an umbrella-like framework, over which is spread a thin, naked membrane continued from the membranous expansion of the body. The whole locomotive power of these animals seems concentrated upon this organ of flight. It can only move along a solid surface by folding its wings and using the hooked thumbs to lay hold of any irregularity, and thus draw itself forwards. Hence its motions are awkward and shuffling; and on a polished surface, like that of a table, it is greatly embarrassed. But in the hollows of trees, the crevices of masonry, and the

chinks or fissures of a rock, it can climb and crawl about with great facility. The air, however, is its home, and through this it moves with considerable swiftness, and with great apparent ease, wheeling in every direction, and performing the most abrupt evolutions in search of its insect prey. In these movements it is very much assisted by the tail, which serves as a rudder; and we shall find that this organ is most developed in bats which pursue insects on the wing, whilst it is small, or entirely wanting, in those which live on fruits. In their mode of flight, bats bear a very strong resemblance to swallows, which like them pursue insects on the wing; but whilst the latter seek their food during the day, the former come forth only at twilight. During the day the bats sleep in their recesses, suspended by their hind feet, their heads consequently hanging downwards; and they assume the same position during the whole winter, which in the temperate zone is passed by them in a state of torpidity.

The bats may be divided into two sections: the carnivorous or insectivorous, and the frugivorous.

Group 1. *Carnivora or Insectivora.*

The insectivorous or insect eating bats are by far the most numerous of the order; they possess a dentition and a digestive system in accordance with their particular kind of food. The molars are beset with pointed tubercles, adapted to crush the hard envelopes of insects; the canines are sometimes of a large size. The intestinal canal is much shorter than in the frugivorous tribe.

The insectivorous bats are subdivided into several families, the number of which is variable according to the views of systematic writers. Some adopt five or six; we only two: the *Vampyridæ* and *Vespertilionidæ.*

The bats existed during the tertiary epoch, and have left some of their remains in the deposits of past ages. As far as hitherto known, they belong to the family of *Vespertilionidæ.* The frugivorous bats are not yet known to have existed prior to our days. We must, however, expect many discoveries to be made in the extinct fauna of this singular order of animals.

FAM. 1. VAMPYRIDÆ. The genus *Dysopes* or *Molossus* (bull-dog bats) belongs both to the old and new world. The snout is simple; the ears are broad and short, arising near the angle of the lips, and uniting with each other on the snout. The tail occupies the whole length of their inter-femoral membrane, and most generally even extends beyond it. Two species of this genus are found in the southern United States. The fossil remains of one species have been discovered in the Brazilian caverns. The genera *Dinops*, *Nyctinomus*, and *Cheiromeles*, are mere subdivisions of this genus.

The genus *Diclurus* (fox-tailed bats), nearly related to the preceding, contains but one species, from tropical America.

The genus *Noctilio* (hare-lipped bats) is distinguished by a short snout,

which is inflated and split into a double hare-lip, covered with old looking warts and seams. The ears are separated. There are four incisors above and two below. The tail is short, and free above the inter-femoral membrane. There are two species of this genus in tropical America.

The genus *Phyllostoma* (javelin bats) possess four incisors in each jaw, some of which fall off by the growth of the canines. The genus is moreover distinguished by a membrane resembling a double leaf that is placed crosswise on the end of the nose. The tongue is very extensible, terminated in papillæ, which appear to be so arranged as to form an organ of suction. Symmetrically arranged tubercles are also observed on the lips. Upwards of twelve species of this genus are known to inhabit tropical America, to which country the genus is completely limited, and where a fossil species has also been discovered in the caverns.

In the genus *Vampyrus* the tail is absent; in other respects it resembles the preceding. One species only belongs to it, *V. spectrum* (*pl.* 117, *fig.* 8), and this is peculiar to the new world, and more especially to tropical America. Its wings measure two or three feet across when expanded.

The genus *Glossophaga* (long-tongued bats, differs from Phyllostoma by a narrow tongue, susceptible of elongation, and furnished with hair-like papillæ. Four species are known, and all of them belong to tropical America.

The genus *Megaderma* (the broad-winged bats) has the leaf-like membrane of the nose more complicated than that of Phyllostoma. The ears are very large, and united on the top of the head. The tongue and lips are smooth; the inter-femoral membrane is entire, and the tail absent. There are four incisors below, but none above. The genus belongs entirely to the old continent; species are found in Africa and in the Indian Archipelago. From the latter locality is *M. lyra* (*pl.* 117, *fig.* 7).

The genus *Plecotus* (long-eared bats) has ears larger than the head, and united on the cranium as is the case in Megaderma. *P. timoriensis* (*pl.* 117, *fig.* 2) belongs here. Two species of this genus inhabit North America, one in the southern States (*P. lecontii*), and the other in Oregon (*P. townsendi*).

In the genus *Rhinolophus* (the horse-shoe bats), the nose is furnished with very complex crests and membranes laid upon the chanfrain, presenting the figure of a horse-shoe; the tail is long, and placed in the inter-femoral membrane. This genus is very numerous in species, all of which belong to the old continent; example, *R. ferrum equinum* (*pl.* 117, *fig.* 6). A fossil species very nearly allied to it is found in the tertiary deposits of Germany.

In the genus *Nycteris* (cheek-pouched bats) the forehead is furrowed by a longitudinal groove, which is even marked upon the cranium, and bordered by a fold of the skin which partly covers it. The nostrils are simple; there are four incisors above and six below; the ears are large and separated, and the tail involved in the inter-femoral membrane. The species are African and Asiatic.

The genus *Nyctophilus* includes only one species, which inhabits the

islands of the South Seas. There are two incisors above, elongated, conical, and indented; and six below, equal and trifid, with rounded lobes; the tail projects a little beyond the inter-femoral membrane.

The genus *Desmodus* (curved-tooth bats) inhabits tropical America, where three species are known; the character of the genus resides in the peculiar formation of the teeth.

In the genus *Rhinopoma* (lid-nosed bats) the groove on the forehead is less distinctly marked than in Nycteris; the nostrils are placed at the end of the snout, above which is a little leaf; the ears are united; the tail extends far beyond the membrane. One species only is known, principally found in the pyramids of Egypt.

The genus *Taphozus* (wing-pouched bats) is distinguished by a little prolongation of the membrane of the wings, which forms a sort of sac near the carpus. The head is pyramidal; no recurved leaf is attached to the nostrils; there is a small rounded pit on the nose. Nine species of this genus are known, some of which belong to the Old, and some to the New World. One particular species was discovered in the catacombs of Egypt.

The genus *Mormoops* contains but one species, proper to the tropical region of the New World, distinguished in having on each side of the nose a triangular leaf, which extends to the ears. There are four incisors in each jaw, the superior tolerably large, the inferior trilobate; the cranium is raised like a pyramid above the snout. One species only, which inhabits tropical America.

FAM. 2. VESPERTILIONIDÆ. The genus *Vespertilio* (bats proper) has a snout deprived of leaf, or any other peculiar appendage; the ears are separated, and independent from each other; the tail is contained in the membrane between the hind limbs. This genus is the most numerous in species, and is found in both the Old and New Worlds. Seven are described from North America, from the Atlantic to the Rocky Mountains, known as hoary bat (*V. pruinosus*), little brown bat (*V. subulatus*), silver-haired bat (*V. noctivagans*,) in the Northern, Middle, and Western States; others are found in the Carolinas and Virginia.

Of European bats we mention the common bat of Europe, *V. murinus* (*pl.* 117, *fig.* 5); *V. noctula* (*pl.* 117, *fig.* 3); and the serotine bat, *V. serotinus* (*pl.* 117, *fig.* 4).

The genera *Emballonura* (long-nosed bats) and *Nycticejus* (roquet dog-bats) include numbers of species allied to Vespertilio, and peculiar to the tropical regions of both the Old and New Worlds.

The genus *Furia* (fury bats) is composed of one species from tropical America, which differs generically from all others.

Of the genus Vespertilio proper, several fossil species have been described from the tertiary strata of the Old World, one of which is very nearly allied to the common bat of the same hemisphere.

Group 2. Frugivora.

The frugivorous tribe of bats has no representatives in the New World; the few genera of which it is composed belong chiefly to tropical Asia. They have molar teeth, with rounded eminences for bruising and grinding their food; their intestinal canal is very long, in some instances seven times as long as the body itself, indicating that these animals were destined to subsist, in part at least, upon vegetable diet. Like many of the monkeys, however, they are probably omnivorous in some degree, feeding chiefly upon fruits, but pursuing small birds, or large soft-bodied insects, which may be obtained without much difficulty. This tribe contains but one family.

FAM. PTEROPODIDÆ. Is characterized by the entire absence of the nose-leaf, the simplicity of the ears, the shortness of the tail. The flesh of many of the frugivorous bats is eaten as a dainty by the inhabitants of the countries in which they are found, having a flavor which has been compared to that of the hare and partridge. Possibly some of the largest kinds were known to the ancients, and gave rise to the fabulous account of the harpy.

The genus *Pteropus* (roussette bats) belongs exclusively to the Old World, and comprehends numerous species. There are trenchant incisors in each jaw, and the molars have flat crowns; the food consists chiefly of fruits, of which these animals destroy large quantities; they pursue birds and small quadrupeds with much success. This genus includes the largest species known of bats; their flesh is eaten; they inhabit the East Indies. The tail is absent, or nearly so; the membranous expansion is deeply notched between the legs; the snout is simple, somewhat elongated, and the nostrils widely separated; the ears are of a middling size. The species belong to Asia and the Indian Archipelago.

The common roussette (*P. vulgaris*) is represented on *pl.* 117, *fig.* 9. These animals generally preserve a perfect silence during the day; but if disturbed, they will emit sharp piercing shrieks.

The genus *Harpyia* (tube-nosed roussette) comprehends a single species, which inhabits Timor. It is a singular looking bat, having nostrils projecting in a kind of cylinder, and a claw on the fore-finger.

The genus *Cephalotes* contains also a single species, from tropical Asia. The membranes of their wings, instead of meeting at their flanks, are joined to each other on the middle of the back, to which they adhere by a vertical and longitudinal partition.

The genus *Macroglossa* (great-tongued roussette) is very closely allied to Pteropus. It is characterized by the extreme length of the head, the absence of false molars, the great development of the posterior molar, and the extensile tongue. One species, from tropical Asia.

The genus *Pachysoma* (stout-bodied roussette) is composed of at least six species, which resemble Pteropus, and are found inhabiting tropical Asia.

ORDER 7. CARNIVORA.

Group 1. *Pinnipedia.*

The seals, which constitute this group, were for a long time not distinguished from the herbivorous Cetacea, the name of sea-cow, now restricted to Manati, being indifferently applied to them, with those of sea-calf, sea-dog, sea-bear, sea-lion, &c. Seals, as already remarked, are also among those curious animals which have given rise to the stories of the mermaids of our forefathers, their head generally bearing some resemblance to that of a dog, whose intelligence (we are told) and soft expressive look they also possess. Some species have very inconspicuous ears, and others have merely an auditory aperture; their jaws are furnished with strong teeth, consisting of incisors, canines, and molars, all well adapted for seizing, holding, and crushing the scaly and slippery prey upon which they feed. The tongue is smooth, and slightly notched at the end; the feet are formed for swimming; the front pair is enveloped in the skin of the body as far as the tarsus, and the hinder pair, which is flattened and directed backwards, is enveloped almost to the heel. All the feet have five toes, the anterior ones regularly decreasing in length from the thumb to the little toe; while in the hinder feet the thumb and the last toe are the longest, and the intermediate ones the shortest. The tail is short, and when the animal is out of the water, is generally concealed by the hind legs pressing close to it. When they dive, they close their nostrils by a kind of valve; and the large venous sinus in the liver must assist them in diving, by rendering respiration less necessary to the circulation of the blood, which in them is very abundant and very dark colored.

These animals pass the greater portion of their time in the water, never landing except for the purpose of basking in the sun and suckling their young. They are excellent swimmers, having an elongated body; a very movable dorsal spine provided with muscles that strongly flex it; a narrow pelvis; short hairs that adhere closely to the skin.

The Pinnipedia form but one family, that of Phocidæ, since we have removed the walruses from this group.

FAM. PHOCIDÆ, or the seals, have six or four incisors above, four or two below, pointed canines, and grinders from twenty to twenty-four, all trenchant or conical, and without any tuberculous part whatever; five toes to all the feet.

The genus *Phoca* includes the species deprived of external ears, provided with pointed incisors; all their toes enjoy a certain degree of motion, and are terminated by pointed nails, planted at the edge of the membrane which unites them. When the number of incisors is six above and four below, we have then the sub-genus *Calocephala*, of which the common seal, *Phoca vitulina* (*pl.* 114, *fig.* 2), is an example. It is from three to five feet in length; found on the coast of Europe in great herds. When the incisors are four above and four below, and the molars deeply notched into three

points, as in the *Phoca leptonix*, from the Australian seas, we have the sub-genus *Stenorhynchus.* The sub-genus *Pelagus* has four incisors above and four below associated to grinders with obtuse cones, with a slightly marked heel before and behind, as in *Phoca monacha* (the monk), from the Mediterranean. When there are four incisors above and only two below, the molars or grinders compressed, slightly trilobate, and supported by thick roots, the species belong to the sub-genus *Stemmatopus.* The hooded seal (*Ph. cristata*), which is an example of the last sub-genus and an inhabitant of the Arctic Ocean, has been noticed on the shores of New England. It is seven or eight feet long; possesses a piece of loose skin on the head, which can be inflated at the pleasure of the animal, and is drawn over the eye when it is menaced, at which time the nostrils also are inflated like bladders. Lastly, when the incisors are four above and two below, but the molars obtuse and conical, and the snout resembling a short movable proboscis, the sub-genus is called *Macrorhinus*, to which the largest known seal (*Phoca leonina*) must be referred. This is the sea-lion, or sea-wolf, or sea elephant of the various writers. It is from twenty to twenty-five feet in length. Common in the northern latitudes of the Pacific Ocean. It constitutes an important object of the fisheries, on account of the oil which it yields abundantly.

The genus *Otaria* is composed of seals with external ears, and besides the four superior middle incisors have a double cutting edge, a circumstance hitherto unknown in any animal; the external ones are simple and smaller, and the four inferior, bifurcated. The molars are simply conical, and the toes of the fore feet almost immovable; the membrane of the hind feet lengthened out into a slip behind each toe; all the nails are flat and slender. The sea-bear (*O. ursina*), eight feet long, is from the North Pacific Ocean. Another species (*O. jubata*) is from fifteen to twenty feet in length; found in all the Pacific Ocean.

Fossil remains of seals proper (Phoca) have been discovered in the tertiary beds of Europe, and referred to three different species, with others not yet determined.

There is also a form found in Germany which differs more widely from the seals proper, and for which the genus *Pachyodon* has been proposed, the full characteristic of which has not as yet been made known.

The genus *Phocodon* is another extinct genus, peculiar to North America and Europe, which, when first discovered among us, was described as a gigantic reptile, and received the name of *Basilosaurus.* Subsequently it was found, by the structure of its teeth and the manner in which the latter were implanted in the jaw, to belong to the class of Mammalia, and to come near the aquatic tribe. By some, however, it is erroneously placed among herbivorous cetaceans. The general character of the teeth reminds us of those of the seals (Phoca), whence the name of Phocodon. They have also the external appearance of the teeth of some sharks, and the name of *Squalodon* was suggested for them by a French naturalist, who had found some of them in the tertiary deposits of Bordeaux. *Zeuglodon* is another appellation for these remains, alluding to the structure of the teeth. One species

is from the tertiary deposits of Alabama, which must have reached a very large size. Another, smaller, is from South Carolina.

The *Trichechidæ*, or walruses, which we have already described among Herbivora, were formerly placed near the seals among Pinnipedia.

The family of *Hydrarchidæ* was established for an extinct genus (*Hydrarchos*), which at first was supposed to have been the most gigantic creature ever called into existence. Indeed it was one of the largest at the time when it lived, but its remains have been found to belong to the genus Basilosaurus, or Phocodon.

Group 2. *Unguiculata.*

This group is composed of those mammals whose food consists chiefly of flesh, generally of a living prey, which they devour with more or less avidity. Some of them, however, the bears for example, have almost a frugivorous diet, eating flesh only by necessity. To these habits correspond a set of teeth fitted for the wants of the animals. The incisors and canines are adapted to seize a prey to the best advantage, and the molars to tear it into pieces. The limbs are sometimes short, and sometimes moderately long, never out of proportion; always strong built, either for the purpose of running after prey or of leaping upon it. The Unguiculata may be divided into two tribes.

Tribe 1. *Plantigrada.*

The animals of this tribe, when walking, place the whole sole of the foot on the ground, a circumstance which enables them to stand vertically upon their hind feet. They partake of the slowness and nocturnal life of the Insectivora. They are all provided with five toes to each foot. Most of those that inhabit cold countries pass the winter in a state of torpor.

Fam. 1. Ursidæ, contains but one genus, *Ursus* (or bears), characterized by a large head, a body and limbs large and powerful, the body itself covered with long and shaggy hairs. The tail is very short. There is no glandular pouch. The number of the molars is variable, the four last are large and tuberculous. Several species of bears are found in North America. In common with the old continent there is the polar white bear, *U. maritimus* (*pl.* 114, *fig.* 11), which inhabits the Arctic seas. The black bear, *U. americanus* (*pl.* 116, *fig.* 10), inhabits the east and north of the United States, whilst in the western regions we have the grisly bear (*U. ferox*). The brown bear of Europe (*U. arctos*) is represented in *pl.* 116, *fig.* 9. Several other black bears are found in the East Indies.

The species of this genus were very numerous during the tertiary epoch, and their remains are found in nearly all bone caverns, especially in Europe. They have also existed in Brazil and the East Indies.

The genus *Amphiarctos* is nearly allied to the bears, from which it differs by the structure of the jaws, in which there is one tooth less. Only one species is known from the Sivalic Mountains.

FAM. 2. PROCYONIDÆ. United by some with the preceding, this family is composed of animals generally smaller than the bears. They have the general appearance of the latter in miniature, but are provided with a long tail, which bears have not.

The genus *Procyon* (racoon) has a short and triangular head, which gives to it a fox-like appearance. The snout is tapering, and projects considerably beyond the mouth. The ears are small. The tail long and bushy, not prehensile. The feet are five-toed, armed with large and strong nails. There is a glandular pouch on each side of the vent. The habits are nocturnal. In eastern North America but one species of this genus is found, the racoon (*P. lotor*), more common in the middle and southern States than in the northern. It is a restless, mischievous animal, feeding on wild and domesticated fowls, frogs, lizards, fish, and insects; it is very fond of oysters. Most usually found in low wooded swamps. A second species is found in California.

The remains of an extinct species of racoon were found in Illinois.

The genus *Ailurus* (panda) includes a racoon-like species from tropical Asia.

The genus *Ictides* or *Arctitis* (benturong) is also composed of East Indian species related to the racoon by their teeth. Their body is covered with long hair, and there is a tuft to each ear. The tail is long, hairy, and has a propensity to curl, as if prehensile.

The genus *Nasua* (coati) belongs to the tropical zone of America. It contains six species, remarkable for their long and flexible snout, by which they are at once distinguished from the racoons. The feet are semipalmated, notwithstanding which they climb trees. Their long claws are used for digging. The brown coati (*N. rufa*) is represented in *pl.* 112, *fig.* 15. A fossil species of this genus occurs in the caverns of Brazil. Another is found in the south of Europe.

The genus *Meles* (badger) is provided with rather large and strong canines. Two of the upper molars are deciduous and fall off when the animal is still very young, so that four only are left in the adult. The nose is somewhat elongated and obtuse at the point; the ears are short and round; the eyes small; the legs short. There are transverse glandular follicles between the anus and the base of the tail which discharge a fetid odor.

The American badger (*M. labradorica*) belongs to this genus. The European badger (*M. vulgaris*) is figured on *pl.* 116, *fig.* 2.

Three fossil species of this genus are on record as having been found in the old continent.

The extinct genus *Trochichis* is intermediate between *Meles* and *Gulo*. It is composed of a single species which inhabited Switzerland during the tertiary epoch.

The genus *Gulo* (glutton) has a head of moderate length, an elongated body supporting short legs, a bushy tail, feet with five deeply divided toes,

terminated by long curved nails. Some species, instead of a glandular pouch, have a simple fold beneath the tail. The habits are nocturnal. Four species of this genus are known: the wolverine or glutton (*Gulo luscus*) existing in the arctic regions of both hemispheres, another in Africa, and two in tropical America.

"This animal," says Buffon, who kept one alive for several months, "is pretty wild; he avoids water, and dreads horses, and men dressed in black. He moves by a kind of leap, and eats pretty voraciously. After taking a full meal, he covers himself in the cage with straw. When drinking he laps like a dog. He utters no cry. After drinking he throws the remainder of the water on his belly with his paws. He is almost perpetually in motion. If allowed he would devour more than four pounds of flesh in a day; he eats no bread, and devours his food so voraciously, and almost without chewing, that he is apt to choke himself."

The French name of *Glouton* is an allusion to its avidity in swallowing its food.

There is one fossil species of the genus Gulo from central Europe, and another from the Brazilian caverns, if it belongs not to another genus.

The genus *Taxotherium* is extinct, and contains but one species from the tertiary basin of Paris. It belongs undoubtedly to this family, and comes perhaps nearer to Procyon than to any other genus.

The genus *Ratelus* (the ratel) approaches the cats by its teeth, while its whole exterior is that of the grison or badger. The legs are short, five toes to each, and the nails very strong. One species, of the size of the badger, inhabits the Cape of Good Hope, where it digs up the earth with its long claws in search of the honeycomb of the wild bees.

Fam. 3. Cercoleptidæ. Composed only of one species, known by the name of potto in tropical America and the West Indies. It constitutes the genus *Cercoleptes*, which gave its name to the family. It has, according to Cuvier, a plantigrade walk, and possesses a prehensile tail. It climbs, like a lemur, with agility, is nocturnal in its habits, and feeds also on some vegetable substances, and we are told by Humboldt that it is fond of the honey of wild bees. It has puzzled all the systematic writers.

Fossil remains found in France, described under the name of *Palæcyon*, seem to belong to this family, or rather the Procyonidæ, if the present one is a mere deviation from the latter. The only species known had been previously named *Arctocyon primævus.*

Again, in the Brazilian caverns, there are remains found which bear the same relation to this tribe as the preceding genus. The genus *Amphicyon* has been proposed for them. It contains several species.

Tribe 2. Digitigrada.

The animals of this group, instead of placing the whole of the foot on the ground, walk on the ends of their toes. None of them pass the winter in a torpid state.

Fam. 1. Mustelidæ. The body is long and vermiform, with short

feet. The neck is elongated. The ears are short and rounded. The tail is long, but rarely bushy; generally diffusing a strong odor, which in some genera becomes a defensive weapon. Five genera of this family are found in North America: *Putorius*, *Mephitis*, *Mustela*, *Lutra*, and *Enhydra*.

The genus *Mustela* (the weasel proper) is characterized by a small and oval head; a snout rather large; ears short and round; a long and vermiform body; a tail usually long and cylindrical; the legs short, each foot provided with five toes, armed with sharp, crooked, and slightly retractile claws. There is no anal pouch, but a small gland which secretes a thickish offensive fluid. The fur is very fine. There are four carnivorous teeth on each side of the upper jaw, and the last carnivorous tooth on the lower jaw has a round lobe on the inner side. Several species of this genus are found in North America, but the largest number belong to the old world. The weasel, fisher, or pekan (*M. canadensis*), as all these names are indifferently applied, formerly very common in every part of the northern and middle States, has greatly diminished and is still diminishing in number with the increased population of the country. It frequents the water edges.

The common marten, *M. martes* (*pl.* 116, *fig.* 3), inhabits the woods. It is extensively hunted in the Adirondack region of northern New York, where it is called sable. The beech marten of Europe, *M. foina* (*pl.* 116, *fig.* 4). The sable (*M. zibellina*), which inhabits Siberia, is highly valued for its rich fur.

Of this genus several fossil species have been described, the remains of which are found in the Old World.

The genus *Palæogale* comes nearest to Mustela, from which it is generically distinct in the structure of the teeth. Two extinct species are found in Wirtemberg.

The genus *Putorius* is composed of species generally small in size, which seldom climb trees like the martens. They emit a fetid odor, and have nocturnal habits. They differ from the martens in having one tooth less on each side of the upper jaw; their snout, short and blunt, is also shorter and thicker than that of the marten. Their head is small and oval; their ears short and round; their body long and vermiform; their neck elongated; their legs short. There are five toes on each foot, armed with sharp crooked claws; the tail is long and cylindrical. Five species of this genus inhabit North America, and twice that number are found on the eastern continent. The mink (*P. vison*) is spread nearly all over North America, inhabiting water courses, and exceedingly destructive to poultry. The ermine, *P. erminea* (*pl.* 116, *fig.* 8), which becomes white in winter, except the tip of the tail, which is always black, inhabits the northern portions of both continents. The American one has been described as a distinct species.

The common polecat of Europe, *Mustela putorius* (*pl.* 116, *fig.* 5); the European weasel, *P. vulgaris* (*pl.* 116, *fig.* 7): and the ferret, *P. furo* (*pl.* 116, *fig.* 6), belong to this genus.

The genus Putorius had representatives during the last period of the tertiary epoch only; a few only are known.

The genus *Mephitis* (skunk) is composed of species emitting a very strong odor from a liquid secreted by anal glands. They burrow in the ground, or dwell in fissures of rocks, living on poultry, birds' eggs, small quadrupeds, and insects. Large families are occasionally found in the same hole. The head in this genus is short, the nose somewhat projecting, and the snout generally blunt. The body is usually covered with long hair, very long on the tail. There are five toes to each foot; the toes of the fore feet armed with long and curved nails, indicating the habit of burrowing in the earth. In walking the heel is very little raised; they are semi-plantigrade. The species of this genus are quite numerous, most of them are South American or Mexican; three are found in North America. The common American skunk (*M. chinga*) is one of them. The two others are also found in Mexico. Of the genus Mephitis, the only fossil remains which are known indicate one species in the caverns of Brazil.

The genus *Mydaus* includes a species from Java (*M. meliceps*), differing from the skunk by a truncated snout resembling that of the hog.

The genus *Palæomephitis* resembles very much Mephitis, but differs from it by a broader and more depressed skull. A single species is known, from the fresh water strata of Wirtemberg.

The genus *Lutra* (the otters) is distinguished from all the preceding genera of the same family by palmated feet, and a horizontally flattened tail. The head is broad and rounded, terminated by a blunt snout. The ears are very short, as well as the legs. The body itself is robust. They have aquatic habits, live along the banks of streams, and feed upon fishes.

The common otter of Europe (*L. vulgaris*) is represented on *pl.* 113, *fig.* 16. We have one species in North America, *L. canadensis* (*pl.* 114, *fig.* 10), very nearly allied to it. Other species of this genus occur in Brazil and in the East Indies.

The genus Lutra had several species in the tertiary fauna of Europe, one of which is the type of Geoffroy's genus *Potamotherium*.

The genus *Enhydra*, which embraces the sea otter, is characterized by six incisors above, as is usually the case, but only four beneath. The body is very long, otherwise resembling the preceding genus.

Enhydra marina is found in North America along the Pacific coast. At one time the fur of this animal was the most valuable known.

FAM. 2. VIVERRIDÆ. This family is composed of small but purely carnivorous animals, chiefly distinguished from the Mustelidæ or weasels in their external characters. They have an anal pouch more or less developed, which serves to secrete an unctuous matter, in some species highly odoriferous. Their tongue is rough, with sharp papillæ. This family is nearly absent in North America; a single species is found in its warmer portions.

In the genus *Viverra* (the civets), the anal pouch is deep, and divided into two sacs; the abundant pomade, which is secreted by the glands of the pouch, has a strong musky odor, and is an article of commerce, used

by the perfumers. It is less employed since musk has become known. The pupil is round during the daytime: the claws are semi-retractile. The species of this genus and the following are chiefly Asiatic and African; a few are met with in the south of Europe.

In the genus *Genetta* (the genets), the pouch is reduced to a slight depression, scarcely perceptible, although secreting and emitting an odor. In the daytime the pupil forms a vertical fissure; the nails are completely retractile, as in the cat.

The genus *Paradoxurus*, with a general resemblance to the genets, has the limbs stouter, and the feet semi-palmated. But what distinguishes it more particularly is the tail; when it is straight, as it is ever carried, it is nevertheless twisted from right to left towards its extremity. Only one species is known, and this inhabits the East Indies.

The genus *Herpestes* contains an animal, the *Ichneumon*, well known by the ancients, and celebrated in Egypt, where it was considered as sacred, and many fables attached to its history. It hunts chiefly for the eggs of the crocodile, and thus destroys a great many of these reptiles. It feeds also on all sorts of small animals. Other species are found near the Cape of Good Hope, and others in Asia.

The genus *Ryzæna* (suricate) is composed of two species from tropical Africa, resembling the ichneumon, but having only four toes to each foot.

The genus *Bassaris* includes only one species (*B. astuta*), from Central America, Mexico, and Texas. In the latter country it is called civet cat. The head is short and pointed; the ears long and oblong; the tail as long as the body. The sole of the feet is hairy.

The family of Viverridæ was represented in the tertiary fauna by several species belonging to the genera *Viverra* and *Genetta*, and one to the genus *Herpestes*, all of which have inhabited Europe. Other fragments yet undescribed seem to indicate that this family has existed in the East Indies and New Holland. No living species exist in our days in Australia.

FAM. 3. CANIDÆ. The snout is elongated and naked. The ears are moderately large, and the tail mostly bushy. The fore feet with five, the hind feet with four retractile claws. They frequently feed on carrion. The dogs, wolves, and foxes belong to this family, of which several species are found in North America.

The fossil Canidæ are numerous, especially those species belonging to the great genus Canis, of which about twenty species have been described. Some of them were undoubtedly wolves and foxes as well as dogs, and inhabited not only the European continent, but also Asia and Brazil. Several extinct genera have been noticed, as follows.

The genus *Speothos* is nearly related to the dogs; the teeth are nearer each other, and the snout less elongated. A single species is known, from the Brazilian caverns.

The genus *Palæocyon*, from the same locality, seems to bear greater affinities with the *C. jubatus*, still living in Brazil, than with any other of the same group. Two species were discovered.

The genus *Hyænodon*, with a certain resemblance to Hyæna, is, how-

ever, more intimately related to Canidæ by the whole of its dentition. This genus contains two species, both from the tertiary beds of France; therefore, as far as hitherto known, a European type.

The genus *Abathmodon*, from Brazil, will perhaps go to the group of Viverridæ, after a more complete study of its remains, or indicate a synthetical type of both Viverrini and Canini. A single species was found in the caverns.

The genera *Galeotherium*, *Harpogodon*, *Agnotherium*, and *Machairodus*, from the tertiary deposits of the Old World, have not yet a fixed place in the system. They will prove to be either viverrines or canines.

We come now to the living fauna of the family.

The genus *Canis* would include all the species of the family, so uniform are they in general form and structure. Nevertheless, for systematic convenience they are subdivided, the name of *Canis* being applied more particularly to the dogs, that of *Lupus* to the wolves, and that of *Vulpes* to the foxes. The dogs and wolves resembling each other more than the foxes, we shall leave them in the same genus, and mention first the domestic dog, *C. familiaris* (*pl.* 116, *fig.* 12), and quote Cuvier on this subject. "He is distinguished by his recurved tail, otherwise varying infinitely as to the size, form, color, and quality of the hair. He is the most complete, singular, and useful conquest ever made by man. The whole species has become his property; each individual is devoted to his particular master, assumes his manners, knows and defends his possessions, and remains his true and faithful friend till death; and all this, neither from constraint nor want, but solely from the purest gratitude and the truest friendship. The swiftness, strength, and scent of the dog have rendered him man's powerful ally against all other animals, and were even perhaps necessary to the establishment of society. Of all animals, he is the only one which has followed man through every region of the globe.

"Some naturalists think the dog is a domesticated jackal, and yet those dogs which have become wild again in desert islands resemble neither the one nor the other. The wild dogs, and those that belong to savages, such as the inhabitants of New Holland, have straight ears, which has occasioned a belief that the European races which approach the most to the original type are the shepherd's dog, *C. familiaris pastoreus* (*pl.* 114, *fig.* 9), and the wolf dog; but the comparison of the crania indicates a closer affinity in the mastiff and Danish dog, subsequently to which come the hound, the pointer, and the terrier, differing amongst themselves only in size and in the proportion of the limbs. The greyhound, *C. fam. leporarius* (*pl.* 116, *fig.* 14), is longer and more lank, its frontal sinuses are smaller, and its scent weaker. The shepherd's dog and wolf dog resume the straight ears of the wild ones, with a greater cerebral development, which continues to increase together with the intelligence in the barbet and the spaniel. The bull-dog, *C. fam. molossus* (*pl.* 116, *fig.* 13), on the other hand, is remarkable for the shortness and strength of his jaws. The small pet dogs, the pugs, spaniels, shocks, &c., are the most degenerate productions, and exhibit the most striking marks of that power to which man subjects all nature."

There are upwards of thirty varieties of dogs enumerated by systematic writers; several of them are represented on our plates. Some we have already quoted in the above paragraph; the remaining ones are the Siberian variety, *Canis familiaris sibericus* (*pl.* 116, *fig.* 11), the badger dog, *C. fam. vertagus* (*pl.* 116, *fig.* 16), and the thin-snouted chase dog, *C. fam. normanus* (*pl.* 116, *fig.* 15).

The varieties introduced in North America are thus enumerated in the Fauna of the State of New York:

Variety *borealis* (Esquimaux dog). Fur long, thick, and woolly beneath; top of the head and back black; nose, cheek, belly, and legs white; ears short and erect.

Var. *lagopus.* White, with patches of blackish grey; ears pointed and erect; foot broad and hairy; tail bushy.

Var. *terræ novæ* (Newfoundland dog). Head broad; nose blunt; ears long, soft, and pendulous.

Var. *canadensis.* Black and grey, mixed with white; ears erect, long, shaggy.

Var. *novæ caledoniæ.* Spotted; body long; legs short, straight; ears erect.

The views of the older systematists as to the origin of the dog have been much modified by more recent investigations. It is now pretty well established that the different races of dogs in different countries are mostly descended from the wolves of their respective regions. This, at any rate, is certainly the case with the different breeds of Indian dogs found in North America, as the Esquimaux dog, the Californian, the Hare Indian, the Missouri Indian, &c.

The wolves may be generally distinguished from the dogs by their straight tail. The common wolf of Europe, *C. lupus* (*pl.* 114, *fig.* 8), the most mischievous of all Carnivora, is found from Egypt to Lapland. The North American species amount already to four well established: the giant wolf (*Lupus gigas*), from Oregon and the Rocky Mountains; the common wolf (*L. occidentalis*), from the plains of Missouri, and confounded sometimes with the European wolf; the prairie wolf (*L. latrans*); and finally, *L. frustror*, from Fort Gibson and vicinity. The Mexican wolf (*L. mexicanus*) is of the size of the common wolf. In the marshes of South America exists a red wolf (*L. jubatus*). The chacal or jackal of the Indies and Caspian Sea (*Canis aureus*) is represented on *pl.* 114, *fig.* 7. In Senegal, again, there is another, which stands higher and is provided with a sharper snout (*C. anthus*), allied to the chacal.

The genus *Vulpes* (the foxes), so nearly allied to Canis, may be characterized by its pointed snout, and its upper incisors, less curved than in the genus Canis. The pupils of the eyes form a vertical fissure. The tail is long, bushy, and cylindrical. Foxes diffuse a fetid odor; they dig burrows, and attack only the weaker quadrupeds and birds. Their habits are nocturnal. The red fox, *V. fulvus* (*pl.* 116, *fig.* 1), and the cross fox (*V. decussatus*), are both found in North America, and considered by some as mere varieties of the same species. The prairie fox (*V. velox*) is smaller

in size than the preceding. Towards the north, beyond the Arctic Circle, the blue fox (*V. lagopus*) is met with, as well as in Norway and Siberia.

FAM. 4. HYÆNIDÆ. Sometimes united with Viverridæ by systematic writers, but differing from them, being generally larger; their fore limbs are longer than the hind ones, making the posterior part of the body stand lower than the anterior, and giving to the back a regular inclination from the head towards the tail. The head is more or less pointed, somewhat intermediate in form between the Felidæ and Viverridæ. They inhabit caverns, and are the most ferocious of all Carnivora, although not the largest. They feed on living animals or on carrion, and often dig up dead bodies from their graves. This family is completely excluded from the New World.

The Hyænidæ seem to have played an important part, as shown in the bone caverns of Europe, during the tertiary epoch. Several species of the genus Hyæna are described, and show in their distribution a wider geographical range than in our days. Two extinct genera (*Smilodon* and *Amyxodon*) exhibit peculiarities which no species of the actual creation presents.

The genus *Smilodon* is peculiar to Brazil, in the caverns of which country the remains were found. It is distinguished from the genus Hyæna by the canines, which are much compressed, nearly lancet shaped. In size and osteological structure they come near the hyena.

The genus *Amyxodon* is Asiatic, and was discovered about the Sivalic Mountains.

The genus *Proteles* is a South African species, the earth wolf of the colonists of the Cape of Good Hope. The body resembles that of Hyæna, the head that of civets, being a little more pointed than usual in Hyæna proper. There are five toes to the fore feet, and four to the hind ones. The canines are of considerable size. The animal is very destructive to the young lambs, and is said to attack the massive fatty protuberance of the African sheep.

The genus *Hyæna* has only four toes to each foot. The teeth are enormously strong, and peculiarly adapted for grinding the hardest bones. The jaws and muscles by which the latter move are also indicative of the greatest strength. The species of this genus are all natives of the warm latitudes of the old world, but excluded from Europe. The striped hyena, *H. vulgaris* or *striata* (*pl.* 114, *fig.* 6), is found from India to Abyssinia and Senegal. Two other species, the brown and spotted hyena, inhabit the Cape of Good Hope.

FAM. 5. FELIDÆ. The head is short proportionally to its length, rounded, and the snout itself short and obtuse. The limbs moderately long and equal sized. The claws are retractile; the habits nocturnal.

We quote the following paragraph from Swainson's Natural History of Quadrupeds:

"The Felidæ constitute the most formidable race of quadrupeds now existing on the earth, the most bloodthirsty in their habits, and the most dreaded by mankind. Their whole structure is evidently formed to effect destruction of the most fearful description. Enormous muscular strength,

surprising activity, great cunning, and an insatiable love for blood, are the prominent characteristics of this race. Among themselves they are unsocial, quarrelsome, and savage; the parent will devour its own offspring; and even the sexes are seldom seen together after the season of courtship. Yet many even of these animals, when they are in confinement, evince some kindness to those from whom they receive their daily food."

The representatives of this family during the tertiary epoch belong to the same generic forms of the existing fauna.

The genus *Felis* (the cats) is the most completely and powerfully armed among all Carnivora. Their short and round snout, short jaws, and particularly their retractile nails, render the largest species the most formidable of animals. The legs and tail are moderately long. The species of this genus are numerous. To it belong the lion, *F. leo* (*pl.* 115, *fig.* 1), of all beasts of prey the strongest and the most courageous, now confined to Africa and some neighboring parts of Asia. The tiger, *F. tigris* (*pl.* 115, *fig.* 2), is larger, has shorter hair, and generally striped; the most cruel of all quadrupeds, and the scourge of the East Indies. The leopard, *F. leopardus* (*pl.* 115, *fig.* 3), inhabits Africa. The panther, *F. pardus* (*pl.* 115, *fig.* 5), found in Africa, Asia, and the Indian Archipelago. Several species are found in North America; one is the jaguar, *F. onca* (*pl.* 115, *fig.* 4), of the size of the panther. The ocelot or panther (*F. pardalis*) and the couguar or puma (*F. concolor*) are two others.

The domestic cat, *F. domesticus* (*pl.* 114, *fig.* 4), is originally from the forests of Europe. Wild (*F. catus*) it is of a more uniform color. In a domesticated state it varies in color, in the length and fineness of the hair; less, however, than the dog. One of these varieties, *F. domesticus angorensis*, the Angora cat, is represented in *pl.* 114, *fig.* 5.

Numerous species of this genus existed during the tertiary epoch, and have left remains of their presence in the deposits of that time. Several have been discovered in South American caverns.

The genus *Lynx* scarcely differs from Felis in the arrangement and structure of the teeth; the only difference is one tooth less in the upper jaw on both sides. The head is short, round, and arched; the ears are short, erect, and more or less tufted. The fore feet have five toes, the hind ones only four. The tail is sometimes much shorter than the body, and sometimes nearly as long. The common American wild cat or bay lynx (*L. rufus*) is found throughout the United States.

The Canada lynx (*L. borealis* or *canadensis*) is another species.

The common European lynx is figured on *pl.* 115, *fig.* 6.

Order 8. Quadrumana.

The order of Quadrumana or four-handed mammals embraces the monkey tribe. The thumb of the extremities is sometimes opposable to the other fingers in both anterior and posterior limbs, sometimes only in the fore ones, giving nevertheless to all of them the power of prehension.

These extremities are also concerned in locomotion. Quadrumana therefore have four hand-like feet; the distinction between the anterior and posterior extremities, so remarkable in man, does not strike us here, except to a very slight degree. These animals climb trees with facility, or may walk on their four limbs, in which case the foot rests only on its outer edge. Sometimes they may stand upright, but this they always accomplish with difficulty.

Quadrumana may be conveniently divided into two groups: the monkeys (*Simiæ*) and the lemurs or makis (*Prosimiæ*), the latter being preceded or followed by two genera whose strange combination of characters has thrown a certain obscurity upon their true affinities.

FAM. 1. CHIROMYIDÆ. The genus Chiromys or aye-aye of Madagascar is the only one which composes this family, and is placed by some among Rodentia. This animal is rare even in its native country. In its general conformation it is strictly lemurine, though having much of the aspect of a squirrel. The extremities have five fingers; the first is separated from the rest, and shorter, so as clearly to represent the thumb, although the latter is not opposable. The first toe is armed with a straight, pointed claw, as in the lemur. Its habits are those of the lemurs, being concealed most of the time during the day in some hollow, and sleeping. At night it issues forth in search of its food, which consists of buds and fruits, with insects and larvæ. The tail is long, and always kept trailing. Each jaw has only two front teeth, very large, strong, flattened, and their roots extend backwards along almost the whole length of the jaw; between these and the molars there is a wide interval, as in the rodents. The molars, however, are simple in their structure. There are two mammæ situated near the groin, as in Rodentia, but again, in the tarsiers, we find two pairs of them, one pair on the chest, the other in the groin. Only one species is known (*C. psylodactylus*), the aye-aye.

FAM. 2. GALEOPITHECIDÆ. This family, like the preceding, is composed of a single genus, the genus *Galeopithecus*, or flying lemur, a native of the Moluccas, Philippines, and other islands of the Indian Archipelago. Its chief peculiarity consists in the extension of its skin between the anterior and posterior limbs on each side, and also between the two posterior limbs, including the tail, so as to form a parachute of considerable extent, which, though it does not enable the animal to fly, gives it support in the air sufficient to enable it to take long sweeping leaps from tree to tree with the utmost facility. The extraordinary combination of characters exhibited by this animal has puzzled the naturalists as to the place which it should occupy in the series of beings. The general aspect of the head is lemurine; the extremities are all furnished with five fingers, but the first or the thumb is separated from the rest, and does not antagonize with them, being short, whilst the remaining ones are nearly equal, and armed with large, deep, hooked, sharp-edged, retractile claws, resembling those of the cat tribe. There are four incisors in each jaw; the canines are absent in the lower; the molars are six on either side in each jaw, and are raised up into pointed tubercles. During the day, these animals remain in the depth of

the fores‘s, suspended like bats from the branches, with the head downwards, and clinging by their hind claws. They are active at night, and traverse the trees in all directions, sweeping from one to another with great address in search of their food, which consists of fruit, eggs, birds, &c. The flying lemur (*G. rufus* or *volans*) is represented on *pl.* 117, *fig.* 1.

FAM. 3. LEMURIDÆ (*Prosimiæ* or *makis*). The animals which compose this family have, like the monkeys, opposable thumbs on both pairs of extremities. The number and form of the teeth are very variable. The general form of the body is slender and elongated; the head pointed and somewhat fox-like. The nostrils terminate at the end of the snout, which is sharp, naked, and somewhat pointed. The eyes are large, as in all nocturnal animals. The first and sometimes the two first fingers of the hind feet are terminated by a long curved claw, a character which at once distinguishes the lemurs from the other Quadrumana. The tail varies in length; sometimes it is large, and sometimes nearly absent; never prehensile. The teeth are more adapted to an animal diet than in the typical Quadrumana; and they show great address in seizing their food, as well as courage in defending themselves when attacked. The hind limbs greatly exceed the anterior ones in length, and make of these animals agile leapers. The greatest number, however, are active only during night, spending the whole day in sleep, and always secluding themselves from the light, which seems painful to them.

Animals belonging to this family are not known in a fossil state.

The genus *Lemur* (makis) includes those species which have been called fox-nosed monkeys, on account of their pointed head. The ears are very small. Their food consists of fruit. The species are numerous and only met with in Madagascar, where they replace the monkeys, none of which are found there. One of them (*L. macaco*) is represented in *pl.* 117, *fig.* 12. Another, *L. pusillus* (*fig.* 11), is the type of the genus *Microcebus* of some authors.

The genus *Lichanotus* (indris) resembles Lemur, but instead of six molars in the lower jaw, it has only four of them. A species (*L. indri*) deprived of a tail, and three feet high, is tamed by the inhabitants of Madagascar.

The genus *Stenops* (loris), the species of which are called the lazy monkeys, have teeth like the lemur, except the molars, the points of which are more acute. The snout is short, the body slender, the tail absent, the eyes large, and the tongue rough. They feed on insects, and occasionally on small birds and quadrupeds. Their gait is excessively slow; their habits are nocturnal. The species inhabit the East Indies.

The genus *Otolicnus* (galago) has the teeth and insectivorous habits of the preceding genus. The tarsi are elongated, and produce a disproportion in the dimensions of the hind feet. The tail is long and tufted; the ears large and membranous; the eyes very great. The species are African, one of which (*O. senegalensis*) is represented on *pl.* 117, *fig.* 10.

The genus *Tarsius* has an elongated tarsus, and all other details of form belonging to the preceding genus; but the space between the molars and

incisors is occupied by several shorter teeth. The snout is very short, and the eyes still larger than in the galagos. The species are from the Moluccas and feed upon insects.

The Monkeys (Simiæ) are divided into two groups or families, one exclusively peculiar to the Old, the other to the New World.

FAM. 4. CEBIIDÆ (SIMIÆ PLATYRRHINI), comprises the monkeys of the New World. They have the nostrils directed laterally and outwards, placed at the side, and wide asunder, and are provided with three false molars on each side of both jaws. The thumb of the fore hands is not opposable to the fingers, and is wanting very frequently. The cheek pouches and callosities are absent. The tail is long and always present, often prehensile, especially in those species that are destitute of thumbs. The molars are six above and six beneath, on each side, a single case excepted, that is one more than the monkeys of the Old World. Cebiidæ are confined to the warmer portions of the New World, from the Caribbean Sea to about the twenty-fifth degree of south latitude, and are especially numerous in those vast forests extending over the plains between the rivers Oronoco and Amazon. All of them are arboreal in their mode of life.

The genus *Hapale* (ouistitis), like the majority of American monkeys, has a rounded head, a flat face, the buttocks hairy. They have only twenty molars, like the monkeys of the Old World. They have compressed and pointed nails, except to the hind thumbs; the thumbs of the anterior extremities are but slightly separated from the fingers. They are pretty little creatures, with agreeable forms, which is seldom the case in monkeys, and are easily tamed. The name of *Iacchus* is restricted to those species whose inferior incisors are pointed and arranged on a curved line equal to the canines. The tail is annulated and well covered with hairs, the ears themselves being generally tufted. In those species in which the incisors are placed on a straight line and less than the canines, the name of *Mydaus* (tamarins) is applied. The tail is not annulated and more slender.

The species are quite numerous, and spread all over the area occupied by the order. Two are known in a fossil state, the remains of which are found in the diluvial deposits of Brazil.

The genus *Nyctipithecus* (night monkeys) has a large and round head, a short snout, very small ears, and large approximating eyes. The tail is long, and covered with short hairs, not prehensile. The nails are all flat. A species lives in Guiana and Brazil.

The genus *Callithrix* (squirrel monkeys) is distinguished by a tail very long and slender, but not prehensile. It has a general resemblance to the squirrels, from which it, however, greatly differs by the shape of the head. The ears are very large, the snout short, and the nostrils narrow. The animals of this genus are little and extremely light creatures, active during daytime and resting during night. Their food seems to consist more of insects, eggs, and small birds, than of fruits; and although habitually gentle and timid, they become animated even to ferocity at the sight of a living prey.

A species of Callithrix has been found in a fossil state in South America.

The genus *Protopithecus* is composed of a fossil species found in Brazil and nearly related to *Callithrix.*

In the genus *Pithecia* the tail is tufted, whence the name of fox-tailed monkeys, which is commonly given to them. These animals live in small troops of ten or twelve individuals, usually residing in the outskirts of forests bordering rivers. They display a morose and savage temper, menacing the offender with their teeth upon very slight provocation.

The genus *Cebus* comprehends the monkeys known as sapajous, sajous, &c., whose tail is covered with fur to its extremity. The latter is prehensile, but not so delicate an organ of touch as in the following genera. The thumb is present on all the extremities. The species are for the most part of small size, and are very lively and docile in their temper as well as active in their movements; somewhat capricious, however, in their disposition. They live in troops in their native forests, feeding on fruits, grains, eggs, and insects. They have been termed *weepers*, from the plaintive, piping noise which many of them utter. The capucin (*C. capucinus*) is represented in *pl.* 118, *figs.* 2 and 3. A fossil species of this genus is described from Brazil.

The genus *Lagothrix* (silver-haired monkeys) has a round head, resembling Ateles, a thumb to the anterior hands, and the tail rather naked. The species live in the interior of South America.

The genus *Ateles* (four-fingered monkeys) is distinguished by the great length, slenderness, and flexibility of their limbs, whence the appellation of spider monkeys, and by the prehensile power of their tail. The anterior thumbs are either totally or nearly hidden under the skin. Their movements on the ground are wanting in firmness, even when they are resting on all the four extremities. Their general aspect is rather that of crawlers than of walkers. They tread on the inner edge of the fore paws and on the outer edge of the hind paws, and endeavor to assist themselves by attaching the tail to any object as they proceed. They often assume the erect attitude, however, and then use the tail as a means of balancing themselves. The proper place for these monkeys, however, is among the branches of the forest, where their movements are very rapid, easy, and unconstrained, as they swing from branch to branch by means of their spider-like limbs and their prehensile tails with the greatest agility. The tail is an organ of touch as well as of prehension; its end is destitute of hair, and furnished beneath with a sensitive skin. It is capable of seizing small objects with great address. These animals are said to introduce the extremity of their tail, as a feeler, into the fissures and hollows of trees, for the purpose of hooking out the eggs or other substances.

The genus *Mycetus* (alouattes), or howling monkeys, is distinguished from the last by their greater size and the diminished length of their limbs; by the presence of a thumb which is, however, not opposable. The head is pyramidal. The howlings uttered by the troops of these monkeys are described by travellers as astounding. They are usually sent forth early in the morning, at sunset, and during the darkness at night; but they are also heard when the overclouded sky threatens an approaching storm. In

disposition the howlers are melancholy and morose; their movements are tardy and inert; and, when on the ground, they never attempt to walk on the hinder limbs alone. They feed principally upon fruits and leaves.

FAM. 5. SIMIDÆ (SIMIÆ CATARRHINI), contains the monkeys of the Old World. They have oblique and very wide-set nostrils, and a human-like system of teeth. They are known as apes, monkeys, and baboons. They may be divided into two sections: The tailed monkeys, by far the more numerous, and the tailless monkeys.

Beginning with those of the first section, we have the genus *Cynocephalus* (dog-headed monkeys), characterized by a long snout resembling that of a dog, and a short tail. These animals are of a large stature and prodigious in force. They never assume voluntarily the erect attitude, and dwell among craggy rocks and precipices, which they climb with great agility. Their diet partly consists of bulbous roots, berries, and grain, and partly of eggs, insects, and scorpions. They are morose and daring in their temper. They congregate in troops, and are bold and skilful in their predatory excursions, maintaining their ground even against large parties of men. The mandrill, *C. maimon* (*pl.* 117, *fig.* 13), is the largest and most ferocious of all the baboons. Another species, *C. sphinx* (*pl.* 118, *fig.* 8), constitute the genus *Papio* of some naturalists. These monkeys are African.

The genus *Inuus* (the magots), or Barbary apes, is characterized by a slightly lengthened snout, the nose being hardly longer than half the length of the face, and not terminal; the tail is very short. One species (*I. ecaudatus*) may be seen on *pl.* 118, *fig.* 9. This is the only quadrumanous mammal which is at present a regular inhabitant of Europe, a large number occurring on the rocks of Gibraltar on both sides of the strait. When young it may be educated in some degree, but as it advances towards maturity it becomes morose, sullen, and mischievous in confinement. In its native haunts, however, it is represented as social, active, and courageous, and is particularly distinguished by its attachment to its young.

The genus *Macacus* differs but slightly from the preceding ones; the snout is lengthened as in baboons, generally more or less in the different genera into which they are subdivided. The tail, however, is longer in this genus; it is pendent, and takes no part in their motions. There are distinct cheek-pouches and callosities. The species inhabit India. Examples: the hare-lipped monkey, *M. cynomolgus* (*pl.* 118, *fig.* 4), and the maned macaque, *M. silenus* (*fig.* 7). A fossil species of this genus is found in England.

The genus *Colobus* is destitute of the thumb; in some species only a rudiment of it may be perceived. Several species of this genus exist in Africa; they are generally of small size, but nothing is known of their habits and distinguishing characters.

The genus *Cercopithecus* (guenons) possesses cheek-pouches, callosities on the buttocks, well developed thumbs to their hands, and a long tail.

They are further known by the annulated or ringed character of their fur, which gives them a speckled appearance. They are slender in their structure, and light and agile in their movements. Their character displays vivacity, impetuosity, and restlessness, with occasional caprice, and petulance. They never abandon the forests, and live chiefly upon wild fruits, and the seeds and buds of trees, with an occasional intermixture of insects and birds' eggs. The true Cercopitheci are confined to Africa. The patras, *C. rubra* (*pl.* 118, *fig.* 5), is from Senegal; the holoway, *C. diana* (*pl.* 117, *fig.* 14), is from Guinea; and *C. griseus* (*pl.* 118, *fig.* 6) from the north-west of Africa.

The genus *Presbytis* (tailed gibbons) is destitute of cheek-pouches and possesses callosities. The arms reach the knees; the tail is very long. The species inhabit India and Sumatra.

The genus *Semnopithecus* differs from the long-tailed monkeys generally by an additional small tubercle on the last of the inferior molars; their long limbs and very long tail give them a peculiar appearance. They have, like gibbons, callosities on the buttocks. The animals included in this genus are commonly termed slow monkeys, from their gravity of habits, and the absence of the restlessness usually seen in the tribe. Several species of this genus inhabit India, Cochin-China, Borneo, and the Malay Archipelago.

The second section of monkeys, those totally without a tail, are subdivided into the following genera.

The genus *Hylobates* (gibbons) has the long arms of the true orangs, and the low forehead of the chimpanse, along with the callous buttocks of the guenons. All the species inhabit the most remote parts of India. Their hands and feet are adapted for climbing. They sweep from branch to branch with arrow-like velocity; their mode is to suspend themselves by their long arms, and by an energetic muscular movement to launch themselves onwards, aiming at distant branches, which they seize with the most wonderful precision; and often without any pause, and almost without any perceptible effort, they swing themselves forwards in a similar manner to another equally distant branch. The most remarkable known species in this respect is the agile gibbon, *H. agilis* (*pl.* 117, *fig.* 15).

The genus *Simia* (orang-outang and chimpanse) is principally confined to the peninsula of Malacca and the great islands of the Indian Ocean One species, the chimpanse, *Troglodytes niger* or *Simia troglodytes* (*pl.* 118, *fig.* 10), inhabits Western Africa; and this is the one which presents the nearest approach to man of the entire group. The conformation of the lower extremities enables it to walk erect with considerable firmness; and, in the same proportion, it is rendered unfit for climbing. All the accounts we possess represent this animal in its natural state as living on the ground rather than among trees. In many respects it exhibits a degree of intelligence which is manifested by no other monkey. The orang-outangs, *Pithecus satyrus*, (*pl.* 118, *fig.* 11), of which several species are known, are natives of Borneo and Sumatra. They are evidently adapted for arboreal rather than terrestrial habits; that is, for living among trees rather than for residing on the ground.

The legs are bowed outwards at the knees, and the soles turned inwards and opposed to one another. The arms are long enough to reach the ground when standing, whilst in the chimpanse they only reach to the knees. The orangs display great unsociability and gloominess of temper. They feed entirely on fruits, and are never known to eat flesh or even eggs in their natural state.

Two fossil species of this genus have been described; one from the tertiary deposits of France; the locality of the other is not positively known. The latter was considered as an extinct genus and called *Mesopithecus* by a German naturalist. Other remains have been discovered in the Sub-Himalayan Mountains.

Geographical Distribution of Mammalia.

Although we have generally mentioned the native country of the animals the history of which we have attempted to sketch out, it still remains for us to throw a rapid glance upon the map of the world, and recapitulate in a few words the distribution of the Mammals over the surface of the earth.

If it can be said that in general water is the element most prolific in animal life, where the animal kingdom displays its richest forms and beauties, this is no longer absolutely true when we consider the class of Mammalia in particular. Although numbers of mammals never leave the water, being bound to it as the prime necessity of their existence, still the majority of forms, the great variety of the class, inhabits dry land.

We shall now take up, one after the other, the different orders of the classes in the order in which we have made them follow each other in the above pages, beginning with Edentata.

The Edentata we have divided into three orders: Monotremata, Edentata proper, and Tardigrada. The Monotremata belong exclusively to New Holland; the Edentata proper belong chiefly to South America, a few species of ant-eaters occurring also in Africa and the adjoining portions of Asia. The Tardigrada are all South American. So that it can be said that the great body of Edentata reside in the South American continent.

Marsupialia are mostly confined to Australia, and there the different families or natural groups are submitted to special laws of distribution in different localities. Some species extend north into the Asiatic Archipelago, comprising the islands of Java, Celebes, Timor, Ceram, Amboina, Banda, and Waigiou. New Guinea and New Zealand possess also Marsupialia. Van Diemen's Land of course possesses its share of Marsupialia. The opossum family (*Didelphidæ*) is found exclusively in the new world, and more particularly South America; a single species extending to the warmer portion of North America. We may say of Marsupialia that their headquarters is in Australia.

The Cetacea are aquatic, and inhabit chiefly the Arctic and Antarctic zones, equally abundant all round the poles, where they acquire a gigantic

size. We are told that Cetacea attained a greater bulk in earlier times than in ours, before whaling expeditions had become so frequent. Cetacea, then, are excluded from the warm regions. Some few of the Delphinidæ are met with in the warm part of the temperate zone. But the Delphinidæ are the smallest of all Cetacea; the large, massive species are inhabitants of the frigid zones, so that the native place of Cetacea is the cold waters of both poles.

The Sirenidia are aquatic, like Cetacea, but less pelagic; they come near the shores, crawl sometimes on the beaches, and ascend the fresh waters a good way above the seas. Some species even are fluviatile. Thus Manati have been found only in the great rivers of South America and of Africa (also in Cuba, Florida, &c.), which discharge their waters into the Atlantic within the tropics, and, as it seems, in the warmer part of the temperate zone on the American continent. The genus Halicore is proper to the Indian Archipelago, and the genus Rytina to the arctic zone; these three genera being the only representatives of the group.

The Trichechidæ (walruses), sub-aquatic or amphibian, as Sirenidia and Cetacea, are inhabitants of the northern seas.

The Pachydermata, after Cetacea the largest mammals, are inhabitants of warm climates. It is a singular fact to be noticed, that animals which occupy a low position in the class should be found in the tropical regions, when we know that Cetacea, which are still lower, belong to the northern latitudes, according to the natural laws of the distribution of the animal kingdom, whose lower groups are always found in the coldest climate. But pachyderms cannot be said to belong to our epoch, and therefore cannot be subjected to the same law. We must therefore find in the past history of the class the reasons of its actual distribution. Let us state now that a single pachyderm is found originating from Europe, the hog, and among pachyderms a small species. In central Asia, six species, one hog also and five horses; in southern Asia, four species, a suiline, an elephant, a rhinoceros, and a horse; and in the Asiatic Archipelago, nine species, an elephant, two rhinoceroses, and six hogs. In the north of Africa, three species only occur, a hippopotamus, a daman, and a hog; in central and southern Africa together, seventeen species, an elephant, a hippopotamus, four rhinoceroses, three damans, four hogs, a tapir, and three Equidæ. In the new world and south, four species are found, two peccaries and two tapirs, one species advancing in the warmer parts of North America. In southern America, three species, two peccaries and one tapir only.

The elephants, rhinoceroses, hippopotamuses, Hyracidæ, suilines, and Equidæ, are exclusively peculiar in the present day to the ancient hemisphere, and, therefore, the majority of the pachyderms. The peccaries are exclusively inhabitants of the New World, and this is nearly the case for the tapirs, a species only being found in southern Africa.

The ruminants are distributed all over the world, and seem created for the temperate region, although some species extend north and south. Ruminants, however, are much more abundant in the old continent in

those parts inhabited by the largest and most carnivorous of Carnivora. In North America, where Carnivora are comparatively scarce, ruminants are much less numerous.

The genus Camelus is peculiar to the old continent, and the genus Auchenia to the new; they are two equivalent groups. The aberrant giraffe is exclusively African. The antelopes proper are also absent from the New World. A single species occurs in North America, the Rocky Mountain antelope (*Antilocapra americana*).

The rodents constitute the most numerous order of the class of mammals, and are at the same time among the smallest.

The family of Leporidæ has representatives both in the Old and New Worlds, but they are chiefly confined to the northern hemisphere; some, like the *Lepus glacialis*, extend into the polar regions. About 35° south latitude is the most southern range of the family in either hemisphere. The great continent of South America has yielded but a single species, and that does not occur south of the Rio de la Plata; whilst, on the other hand, it is in North America that the species are proportionally more numerous. In the Old World, the group in like manner almost disappears in the tropical portions; it reappears, however, south of the tropics, there being several species found at the Cape of Good Hope. But one species has been discovered in the Indian islands, and in Australia there are no hares; indeed, all Rodentia found in that continent belong to the family Muridæ.

The hystricine rodents are essentially South American, and under that head we include Hystricidæ, Dasyproctidæ, Echimyidæ, Octodontidæ, Chinchillidæ, and Cavidæ. Hystricidæ has a wide geographical range, having representatives in the four quarters of the globe, with the exception of two species, *Aulacodus swinderianus* and *Pteromys typicus;* the whole of the species forming the five remaining sub-families are exclusively found in the New World, being chiefly confined to South America. Two or three species in the West India islands, and about the same number in Central America, form the exceptions. The members of the Hystricidæ, Dasyproctidæ, and Echimyidæ increase in number towards the tropical portion of South America; whilst in the southern part of that continent, the less highly organized species only are found, these being members of the Octodontidæ, Chinchillidæ, and Cavidæ. On the western side of the southern Andes the Octodontidæ alone have representatives.

The Saccomyina are exclusively American, from the extreme north to Colombia and Guiana, the greatest development of the group being in Central America.

The Bathyergina are African, three species constituting the group, forming two genera. The Arvicolina are excluded from Africa and Australia, but are found in North America, Northern Asia, and Europe. The Spalacina are not found in the New World; three species are European and three African; the remainder are Asiatic. The Murina are common to both hemispheres. The domestic mice and rats have spread all over the world; each country also possesses its own kinds. Furthermore, we

observe in that extensive group other genera limited to either one of the continents. Thus seven genera belong exclusively to Asia, six exclusively to Africa, two to Australia, whilst five others are found in South America alone, and two again in North America. A few others are common to Europe and Asia, and still others to Asia and Africa.

The group Ctenodactylina is African with one single species.

The Dipodina is European, North Asiatic, and North African; one species only occurring in North America.

The Myoxina is excluded from the new world; the species of this group are chiefly European, two are Asiatic, and a few North African.

The Sciuridæ are equally common to North America, Europe, Asia, and Africa. The genus Pteromys is Asiatic and North American; the genus Anomalurus, African; the last continent possessing besides that genus only a few species of Sciurus.

The genus Aplodontia is North American.

The Insectivora are completely absent in the Australian provinces. Among Talpidæ, or moles, the genera Cendylura and Scalops are North American; the genus Chrysochloris is from tropical Africa, with one species in tropical America; and the genus Talpa (mole proper) from temperate Europe.

The shrews, or Soricidæ, are quite as much limited. The shrews proper (Sorex) are European, African, and Asiatic. The genera Hylogale and Hylomys are from tropical Asia; the genus Mygale from temperate Europe; and the genus Macroscelides from the Cape of Good Hope. The family of Erinaceidæ, or hedgehogs, possesses species of the genus Erinaceus in Northern Africa, Asia, and Central Europe. The genus Centetes belongs to tropical Africa, and the genus Gymnura to tropical Asia.

The Cheiroptera, or bats, we have seen above, are divided into two groups according to the nature of their food, the Frugivora and Insectivora.

The insectivorous bats constitute the main bulk of the order. They abound chiefly in the tropical provinces, where they reach their greatest diversity. Two species occur in Australia, a bat proper (Vespertilio) and a bull-dog bat (Dysopes); species of the last genus being found also in tropical America, Africa, and Asia, with a single species in Europe. The genera Dididurus, Noctilio, Vampyrus, Phyllostoma, Glossophaga, Desmodus, Mormoops, and Furia all belong to tropical America. In temperate South America there is only one species of bat proper to be found. In arctic America only one species of Vespertilionidæ. In tropical Africa we have a single genus which is not found elsewhere; this is Rhinopoma. Several genera have species in both tropical Africa and Asia, such as Megaderma, Nycteris. The other genera have a wider range; Vespertilio is cosmopolite; of the latter group a species exists in arctic America, seven in arctic Europe, and six in arctic Asia.

The frugivorous bats are totally excluded from the New World. One species of Pteropus is a native of Australia; the other species of the same genus belong to the oceanic provinces, tropical Africa, tropical and central Asia. The genus Pachysomus is exclusively proper to tropical Asia; the

genera Macroglossus, Harpyia, and Cephalotes are at once Asiatic and Oceanic.

The aquatic Carnivora, the Pinnipedia or seals, are again rather northern and temperate than southern and tropical. These animals are met, with the Rytina of the Sirenidia group, generally near and beyond the arctic circle.

Among terrestrial Carnivora, if we examine first the Plantigrada we find that they are absent from Australia, the oceanic provinces, and the temperate part of South America. In North America five or six species. In both tropical America and Asia they abound most; the genus Ailurus belongs exclusively to the latter country, whilst Cercoleptes is tropical American. The genera Nasua and Procyon are peculiar to the New World; the genus Arctitis is peculiar to Asia. The badgers (Meles) are chiefly European and North American; the bears are more widely spread.

The Digitigrada have a wider distribution than the Plantigrada. Australia possesses one species of dog; the oceanic provinces have a dog and a Paradoxurus; and temperate South America has several skunks, dogs (Canis), otters, and cats. The cats, dogs, and martens are distributed over a wider area than the other genera. The genus Hyæna is African and Asiatic; the genus Bassaris is tropical American; the genera Cynictis, Proteles, and Pyræna belong to tropical Africa. The ichneumons are chiefly African and Asiatic. The Lingsang and Potomophilus are limited to tropical Asia. The greatest development of this division is in tropical Africa and Asia, next in Central Asia, then in tropical America.

The Quadrumana or monkeys, as already remarked, divide into two groups, one exclusively proper to the Old, the other to the New World.

The first section of the Quadrumana of the Old World is that of Prosimiæ, Lemuridæ, or makis, which is distributed over western and central Africa, the island of Madagascar and adjacent islands, the south Asiatic provinces, and the Indian Archipelago. To the latter districts belongs exclusively the genus Tarsius. The genera Otolicnus, Lichanotus, and Lemur are African.

The Simidæ are all African and Asiatic. The genus Colobus is peculiar to Africa, whilst the genera Presbytis, Semnopithecus, and Hylobates belong exclusively to Asia.

The Cebiidæ are from tropical and temperate South America.

The group Chiromyidæ is composed of one species which inhabits Madagascar.

That of Galeopithecidæ also comprises one species, peculiar to the Indian Archipelago.

With this sketch of the geographical distribution of mammals we close the class of Mammalia, which is the last of the animal kingdom if we except Man, to whose natural history we devote the entire last subdivision of this volume, under the head of ANTHROPOLOGY.

ANTHROPOLOGY AND SURGERY.

PLATES 119—140.

GENERAL CONSIDERATIONS.

1. Position of Man in Organic Nature.

LINNÆUS placed man at the head of the animal kingdom, presenting what he deemed his most important characteristic, in the specific name *Sapiens.* Other naturalists have expressed themselves quite indignantly against even this approximation to the brute creation, denying the propriety of grouping man with other Mammalia. Nevertheless, it is impossible to deny that in many respects there is a close resemblance to the higher quadrumana in many external features, and a still more intimate relation in the fundamental points of anatomical and physiological structure. By placing him in the order *Bimana,* of which he is sole occupant, we make a zoological difference from the monkeys and apes, this difference being vastly increased by the presence of intelligence and reason.

However great the resemblance between Man and the Quadrumana, yet the differences, as already remarked, are sufficient to prevent their ever being approximated more closely than we have done. Thus, a perfectly opposable thumb is unknown among the monkey tribe; this member, although capable of grasping objects, is yet unable to act with the delicacy and precision so eminently characteristic in man. The erect attitude, too, is man's sole prerogative; this involving numerous differences in general structure. Another point of difference is to be found in the different facial angle; this being such as to throw the face immediately beneath the brain, and not anterior to it. This facial angle is formed by two ideal lines, one drawn from the most projecting portion of the forehead to the anterior extremity of the alveolar margin of the upper jaw, the other extending from the latter point in a horizontal direction through the meatus auditorius externus. The development of brain will generally be found to bear a certain ratio to the obtuseness of this angle. *Pl.* 119, *fig.* 10, exhibits the facial angle of the European; *fig.* 11, that of the negro; and *fig.* 12, that of the orang-outang.

Other important characteristics of mankind are to be found in the absence of any intervals between contiguous teeth, and in the vertical position of the latter; in the comparatively small size of the face, the prominent chin, the broad foot, the long muscular legs; in his capacity of living under great extremes of heat and cold; his adaptation to a purely animal or vegetable

diet, as well as to a mixture of the two, &c. But by far the most important characters are to be found in those mental endowments which distinguish him so eminently from the brute.

2. Varieties of Mankind.

It is not our purpose to enter upon the question now agitating the scientific world, as to whether mankind be descended from one pair or from several; and if the latter, whether these original pairs were of one single species, or of a greater number. The problem is still far from being solved, requiring the combined efforts of the anatomist, the physiologist, the zoologist, the philologist, and the theologian. Nowhere is a severe application of all the principles of modern scientific investigation more necessary to a satisfactory conclusion than in this instance.

Any attempt at a systematic classification of man, as at present distributed over the surface of the globe, is attended with great difficulties. Although in typical individuals of different nations strongly marked features of distinction may be observed, yet, when we attempt to include mankind in one general arrangement, we find such an endless variety, such insensible gradations from one form into another, such unexpected anomalies in particular circumstances, as almost to cause the ethnologist to throw down his pen in despair. It is for this reason that different authors have had such apparently contradictory views as to the number of principal races, and their proper sub-divisions. Thus, Desmoulins gives sixteen such races; Bory de St. Vincent, fifteen; Prichard, seven; Blumenbach, five; while Cuvier makes only three. The five races of Blumenbach are termed by him:—Caucasian, Mongolian, Ethiopian, Malay, and American. Cuvier refers the Malay race to the Ethiopian, and the American to the Mongolian, leaving only the Caucasian, Mongolian, and Ethiopian.

Dr. Chas. Pickering, in his important work entitled "The Races of Man," gives eleven races, as follows:

a. White.

1. Arabian. Nose prominent; lips thin; beard abundant; hair straight and flowing.
2. Abyssinian. Complexion hardly becoming florid; nose prominent; hair crisped.

b. Brown.

3. Mongolian. Beardless; with the hair perfectly straight, and very long.
4. Hottentot. Negro features, and close woolly hair; stature diminutive.
5. Malay. Features not prominent in the profile; complexion darker than in the preceding races; the hair straight, or flowing.

c. Blackish-brown.

6. PAPUAN. Features not prominent in the profile; beard abundant; skin harsh to the touch; hair crisped or frizzled.

7. NEGRILLO. Apparently beardless; stature diminutive; features approaching those of the negro; hair woolly.

8. INDIAN or TELINGAN. Features approaching those of the Arabian; the hair in like manner straight or flowing.

9. ETHIOPIAN. Complexion and features intermediate between those of the telingan and negro; hair crisped.

d. Black.

10. AUSTRALIAN. Negro features, combined with straight or flowing hair.

11. NEGRO. Close woolly hair; nose much flattened; lips very thick.

In the present brief reference to the principal subdivisions of the human race, we shall follow Latham, who, in his recent work entitled "Natural History of the Varieties of Man," has treated of the subject in a highly scientific manner, and has given to it as much precision as perhaps it is capable of at the present time.

The following table exhibits the principal divisions and subdivisions employed by Mr. Latham, and we shall take up their consideration in the same order:

Mongolidæ.	Altaic.	Seriform.			
		Turanian.			
	Dioscurian.				
	Oceanic.	Amphinesian.			
		Kelænonesian.			
	Hyperborean.				
	Peninsular.				
	American.				
	Indian.				
Atlantidæ.	Negro.	Western,	Central,	Eastern.	
	Caffre.	Western,	Southern,	Eastern.	
	Hottentot.	Hottentot,	Saab.		
	Nilotic.	Gallahs,	Agows,	Nubians,	Bisharis.
	Amazirgh.	Siwans,	Cabyles,	Tuaricks,	Guanches.
	Egyptian.				
	Semitic.				
Japetidæ.	Occidental.				
	Indo-Germanic.	European.	Gothic.		
			Sarmatian.		
			Mediterranean.		
		Iranian.			

Our limits will permit us to give a very brief diagnosis only of even the principal of the above divisions, with an indication of their geographical distribution.

1. MONGOLIDÆ. The characteristics of the *Mongolian* family are to be found in a face broad and flat, from either the development of the zygomata or that of the parietal bones, often from the depression of the nasal bones. The frontal profile is retiring or depressed, rarely approaching the perpendicular. The maxillary profile is moderately projecting, rarely vertical. Eyes often oblique. Skin rarely a true white, and as rarely a true black. The irides are generally dark. The hair is straight, lank, and black, rarely light colored; sometimes curly, rarely woolly. Found in Asia, Polynesia, and America.

According to the above table, the Mongolidæ are divided into Altaic, Dioscurian, Oceanic, Hyperborean, Peninsular, American, and Indian.

A. The term ALTAIC Mongolidæ is derived from the Altai Mountains in Central Asia, as being a convenient geographical point of reference for the nations and tribes comprised in this division. It contains as subdivisions, two principal stocks, the Seriform and Turanian.

The *Seriform stock* is Mongol in its physical conformation, and is distributed over China, Thibet, the Trans-Gangetic Peninsula as far as Malaya, the Himalayan and parts of the Sub-Himalayan range of mountains.

The principal divisions are: 1. *The Chinese*, found in China, and having for religion a modified Buddhism, or the religion of Fo. The Chinese, with the yellowish-brown complexion, broad face, scanty beard, lank, black hair, and small stature of the Mongolidæ in general, have for their especial characteristic an opening of the eye very narrow, and drawn upwards at its outer angle, so as to render it very oblique. 2. *The Thibetans*, inhabiting Thibet, Butan, &c. Their religion is chiefly Buddhism, although Brahminism prevails on the frontier of India, and Shia Mahometanism in Little Thibet. 3. *The Anamese*, in Tonquin and Cochin-China. Their language is allied to the Chinese, although actually different. In physical appearance they resemble the Chinese, although of somewhat less size, and with the eyelids not so oblique. 4. *The Siamese*, from the Gulf of Siam to the frontiers of China. Their religion is Buddhism. 5. *The Kambojians*, inhabiting the lower course of the Mekhong River, between the Siamese and Anamese. 6. *The Burmese*, in the valley of the Irawaddi. 7. *The Môn*, inhabiting the delta of the Irawaddi, and speaking much the same language as the Burmese. There are also numerous minor nations which appropriately belong to the Seriform Altaic Mongolidæ.

The *Turanian stock* inhabits the northern parts of the Chinese Empire, the greater portion of Siberia, Mongolia, Tartary, eastern Turkestan, Asia Minor, Turkey, Hungary, Finland, Esthonia, and Lapland. Four principal divisions may be established, as follows: 1. *The Mongolian branch*, found from the Altai Mountains to the Wall of China, and from the Tungús boundary to Thibet. Their religion is chiefly Buddhism. It includes the Calmucks, and is characterized by presenting the typical features of the Mongolidæ, and by the pastoral and nomadic habits of its tribes. 2. *The*

Tungus branch. This is found from the Sea of Okhotsk and Kamtschatka to the Yenisei, and from the coast of the Icy Sea to the Yellow Sea. Their position is thus more northern than that of the preceding, while their habits are more those of the hunter and fisherman than of the shepherd. 3. *The Turk branch*, extending from Lake Baikal to the eastern boundary of the Greek and Slavonic countries of Europe, and from the northern frontier of Thibet and Persia to the country north of Tobolsk. They are also found isolated in regions exterior to the preceding limits. Their religion is mostly Sunnite Mahometan. 4. *The Ugrian branch.* This extends from Norway to the Yenisei, and from the North Cape to Simbirsk, Saratof, and Astrakhan. It is also found isolated in Hungary. Although essentially Mongolian, there is a frequent occurrence of blue eyes and red hair. Their religion varies in different sections of country, the Lutheran, Roman Catholic, Greek Catholic, and Shaman predominating. The principal nations included in this branch are the Voguls, Ostiaks, Finns, Finlanders, Esthonians, Laplanders, and Magyars or native Hungarians.

B. THE DIOSCURIAN MONGOLIDÆ derive their name from the ancient sea-port Dioscurias, where the chief commerce between the Greeks and Romans and the natives of the Caucasian range took place. It includes the nations inhabiting the range of Mount Caucasus, and by authors previous to Latham presented as the type of the Caucasian race, and allied with the inhabitants of civilized Europe. But in the confessed absence of authentic and extended osteological and zoological information, this acute ethnologist, from philological grounds, has felt himself compelled thus to alter the generally received classification. The principal divisions are:—1. *The Georgians;* 2. *The Lesgians;* 3. *The Mizjeji;* 4. *The Irôn;* 5. *The Circassians.*

C. THE OCEANIC MONGOLIDÆ consist of tribes which, with the exception of those on the Peninsula of Malacca, inhabit islands exclusively. They may be divided into two stocks, Amphinesian and Kelænonesian.

The Amphinesian stock is sub-Mongolian in physical appearance, with a complexion of various shades of brown or olive, rarely black. The hair is black and straight, rarely woolly; oftener (but not often) wavy and curling. Stature from five feet three to five feet ten. The language contains a certain proportion of Malay words. This stock is distributed over the Malayan Peninsula, the Indian Archipelago, Polynesia, and, perhaps, Madagascar. Its chief subdivisions are: 1. *The Protonesians.* Here the color is of different shades of brown and yellow. The face is flat; the nose short; eyes and hair black and straight; beard scanty; stature short; frontal profile retiring; jaws projecting; orbits angular. They inhabit the Malayan Peninsula, Sumatra, Borneo, Java, &c. It is here that we find the typical Malays, so well known both for their virtues and their vices. 2. *The Polynesians.* This section includes inhabitants of islands from the Pelews to Easter Island, and from the Mariannes and Sandwich Islands to New Zealand. In stature they perhaps exceed the Protonesians, with a more common tendency to corpulence. The color often approaches to that of Europeans; the hair frequently waved or curling; the nose

sometimes aquiline. Their diet consists principally of vegetables, the cocoanut, the taro, and the banana; when of animal food, it is chiefly fish, sometimes of pigs and dogs, in the almost entire absence of larger mammals. The bow and arrow are rarely used as weapons, but in their stead the club and spear. Of Polynesians there may be distinguished two branches, those inhabiting the Pelew, Caroline, and Marianne Islands, and those found in the Navigator, Society, Friendly, and other islands of the Pacific, in the Marquesas, Easter Island, Sandwich Islands, New Zealand, &c.

The Kelænonesian stock has at first sight strong affinities with the black races of mankind, the color of the skin being black, rather than brown or olive. The hair is crisp, curly, frizzly, and sometimes perhaps woolly; scarcely straight; color black. Stature rather small. It inhabits New Guinea, New Ireland, Solomon's Isles, the Louisiade, New Hebrides, New Caledonia, Australia, and Tasmania. Here the bow and arrow are the prominent weapons. In this area may be distinguished three principal branches: 1. The Papuan; 2. The Australian; 3. The Tasmanian.

D. THE HYPERBOREAN MONGOLIDÆ are found along the coasts of the Arctic Ocean and the courses of the Yenisei and Kolyma, thus occupying the most northern part of the inhabited world. They are constituted by the three divisions of *Samoeids*, *Yeniseians*, and *Yukahiri.*

E. The division of PENINSULAR MONGOLIDÆ comprises tribes separated by considerable breaks geographically, and to some extent, apparently, ethnologically. Some lie within the Arctic circle, others extend as far south as 26° north latitude, while an equal difference is seen in their social development. They inhabit islands and peninsulas of northeastern Asia. The principal subdivisions are as follows: 1. *The Koreans*, on the peninsula of Korea; 2. *The Japanese;* 3. *The Lu-Chu Islanders;* 4. *The Aino;* 5. *The Koriaks;* 6. *The Kamtschatkians*, in the southern part of the peninsula of Kamtschatka.

F. THE AMERICAN MONGOLIDÆ. These include two principal subdivisions: 1. The *Esquimaux*, and 2. The *Indians* of North and South America. The former are not confined to North America, being found in Greenland and northeastern Asia; the latter constitute exclusively the aboriginal inhabitants of the continent.

G. THE INDIAN MONGOLIDÆ include the inhabitants of Hindostan, Cashmere, Ceylon, the Maldives and Laccadives, and part of Beloochistan.

2. ATLANTIDÆ. In the second great family of mankind we find, as the predominant characters, the maxillary profile projectile, the nose flattened, the forehead retreating, the cranium long, with the parietal diameter generally narrow. The eyes are rarely oblique. The skin is often jet black, very rarely approaching a pure white. The hair is crisp, woolly, rarely straight, still more rarely light-colored. The Atlantidæ are almost exclusively inhabitants of Africa, being found in Asia only on the African side. They may be divided into the Negro; the Kaffre; the Hottentot; the Nilotic; the Amazirgh; the Egyptian; and the Semitic Atlantidæ.

A. THE NEGRO ATLANTIDÆ are distinguished by the black, soft, and

unctuous skin; the woolly hair; thick lips; projecting jaws; retreating forehead, and flattened nose. They inhabit the low lands and sea portions of Africa, with the delta and courses of the Senegal, Gambia, Niger, Upper Nile, and other rivers of the same continent. Geographically they may be divided into, 1. the *Western*; 2. the *Central*; and 3. the *Eastern*.

B. THE CAFFRE ATLANTIDÆ are subdivided into, 1. *The Western*; 2. *The Southern*; and 3. *The Eastern*. Here the cranium is more vaulted than in the Negro, with the snout less projecting. The hair is tufted, as such approaching the Hottentot; the zygomatic development outwards rather than downwards, so that the cheek bones become projecting, and the forehead and chin tapering. Lips generally thick, and nose less depressed than in the Negro. Color black, dark brown, or clear brown. Stature tall. They occupy western, central, and eastern Africa, from the north of the Equator to the south of the Tropic of Capricorn.

C. THE HOTTENTOT ATLANTIDÆ are low of stature and slight of limb. In color they are more brown or yellow than black; cheek bones prominent; nose flattened; hair in tufts rather than equally distributed over the head. Eyes oblique; vision acute. Cranium Mongol-like, with wide orbits; chin long, forward, and thin. There are also striking features in the osteology and general anatomy of the Hottentot, to which we cannot here allude. They inhabit elevated table-lands and terraces, generally sterile and ill adapted to furnish vegetable food. The flesh of the larger mammals, with that of reptiles and insects, is an important article of diet. Their principal divisions are into *Hottentots* proper and *Saabs*, the former found on the Great Fish River and Orange River, the latter in the country between the Roggeveld and the middle portion of Orange River.

D. NILOTIC ATLANTIDÆ. This division includes the inhabitants of the water system of the Upper and Middle Nile. In external appearance they differ somewhat from the true Negro type, approaching to that of the Arab. They are divided into *Gallas*, *Agows*, *Nubians*, and *Bisharis*.

E. THE AMAZIRGH ATLANTIDÆ inhabit the north-western portion of Africa, together with a narrow strip along the Mediterranean, from about 15° east longitude to the confines of Egypt. They are interesting as being the descendants of the ancient Gætulians, Numidians, Mauritanians, and Cyrenæans. In physical appearance they resemble sometimes the Negro, sometimes the Arab. Their chief divisions are: 1. *The Siwans* of the oasis of Siwah; 2. *The Cabyles* of Mount Atlas; 3. *The Tuaricks* of the Sahara; and 4. *The Guanches* of the Canary Islands. The latter have now no distinct existence.

F. THE EGYPTIAN ATLANTIDÆ. By these are to be understood the old Egyptians, the subjects of the Pharaohs and the Ptolemies, and the modern Copts, as far as they are of unmixed blood. They inhabited and still inhabit the valley and delta of the Nile, from Assouan to the Mediterranean.

G. SEMITIC ATLANTIDÆ. These are composed of light complexioned tribes, with sub-depressed skulls, straight and prominent noses, and vertical profile. They are referable to three principal types, the *Arab*, the *Jew*, and

the *Kaldani.* Their principal divisions are into Syrians, Assyrians, Babylonians, Arabs, Ethiopians, Phœnicians, Jews, &c.

3. THE JAPETIDÆ constitute the third and last division of the table prefixed to this article. It is this which includes the majority of the present inhabitants of civilized Europe, and is found in many other portions of the world, originally colonized from Europe. In this family the jaws project but slightly, the nose is mostly prominent, the facial outline sometimes nearly vertical. Face rarely very flat; moderately broad. Eyes rarely oblique. The skin is white or brunette. Hair never woolly, often light colored. Irides black, blue, or grey. Divided into Occidental and Indo-Germanic.

A. OCCIDENTAL JAPETIDÆ. The Celts of Brittany, Wales, Highlands of Scotland, the Isle of Man, and Ireland, are the principal representatives of this section. In physical conformation they are presented under two principal types. 1. *The Silurian*, with eyes and hair black; complexion dark with a ruddy tinge; chiefly found in South Wales. 2. *The Hibernian*, with grey eyes, yellowish, red, or sandy hair, and light complexion.

B. INDO-GERMANIC JAPETIDÆ. Of this division we may make two classes, 1. European; 2. Iranian. In the *European Indo-Germanic class* we find three subdivisions.

1. *The Gothic:* with blue eyes, flaxen hair, ruddy complexion, smooth skin, and fleshy limbs; or else with grey, dark, or hazel eyes, brown or black hair, and sallow or swarthy complexion. Found at the present time in Germany and Scandinavia, Switzerland, Holland, Belgium, Great Britain, Ireland, United States, Canada, and Australia. Descended from the ancient Germans of the region between the Rhine and the Elbe. It may be divided into the *Teutons*, having as subdivisions, again, the Mœso-Goths, High Germans, and Low Germans; and into the *Scandinavians*, including the Icelanders, Faroers, Norwegians, Swedes, and Danes.

2. *The Sarmatians*, including the *Lithuanians* (old Prussians, Lithuanians, and Letti), and the *Slavonians* (Russians, Servians, Illyrians, Tshechs, Poles, Serbs, and Polabi).

3. *The Mediterranean*, inhabiting Greece and Italy, subdivided into the *Hellenic* and *Italian* branches.

The *Iranian Indo-Germanic class* includes the inhabitants of Kurdistan, Persia, Beloochistan, Affghanistan, and Kafferistan.

The figures on *pl.* 119 present some of the typical subdivisions to which we have just had reference. *Figs.* 1 and 2 represent individuals of the German nation; *fig.* 3, an Arab; *fig.* 4, a Finn; *fig.* 5, a Chinese; *fig.* 6, a true Negro; *fig.* 7, a North American Indian; *fig.* 8, a South American Indian; *fig.* 9, a Malay. *Fig.* 10, the skull of a Caucasian; *fig.* 11, that of a Negro; *fig.* 12, that of an ape. The chart in the centre of the plate is intended to exhibit at a glance the present distribution of the five races of Blumenbach, as explained in the margin. The translation of the German phrases on the plate will be found in the table of contents at the beginning of this volume.

3. Internal Structure and Vital Phenomena of Man. 000

Investigations in reference to the corporeal nature of man are carried on under two points of view, one having respect to his anatomy, the other to his physiology. By *anatomy*, is to be understood the structure of the animal machine, with the form and constitution of the individual parts; while *physiology*, on the other hand, seeks to explain the office or function which each part of the system plays in the animal economy.

Human Anatomy is divisible, in the first place, into General and Special. General Anatomy treats of the minute individual components of the body; their varieties of structure, their peculiarities, and their mode of combination; it stands in very close connexion with the chemistry of the human body. Special Anatomy refers to the individual organs, teaching their forms, magnitudes, positions, and connexions with the other parts of the body.

4. Constituents and Elementary Tissue of the Human Body.

The human body consists of solid, liquid, and gaseous substances, so intimately united as to be only separable by artificial means. All solid particles, for instance, are penetrated by liquid, and these contain gaseous in solution. In addition to these, there are cavities in various portions of the body, more or less moistened or filled with collections of liquid matter, not to speak of the gases contained in the lungs, the intestinal canal, &c.

The liquids of the human body constitute its principal mass, amounting to nearly four fifths of the entire weight. They consist in part of a watery matter, generally distributed throughout the body, and containing a little albumen and a few salts in solution; partly of nutritious juices, as the blood, the lymph, and the chyle; and partly of secretions, which are separated from the blood to be entirely thrown off, or else used for some special purpose. Thus we have serous liquids in the cellular tissue, in various closed cavities, in the chambers of the eye, and in the inner ear: albuminous are found in the synovial membranes and the vitreous humor of the eye: fats occur in the cellular tissue and in the marrow of bones: coloring matters in the blood, the muscles, and under the skin of certain races.

All the components of the body may be reduced to fifteen elementary constituents, which, however, are not peculiar to it. These are oxygen, hydrogen, nitrogen, carbon, sulphur, phosphorus, sodium, chlorine, fluorine, potassium, calcium, magnesium, manganese, silicon, and iron.

Some principal organic combinations of these elements in the human body are as follows: *tears; saliva; crystallin*, in the crystalline lens; *biliary resin, biliary sugar* (bilin), *taurine, bilifulvin, cholesterin, dyslysin, &c.*, in the bile; *uric acid* and *urea* in the urine; *caseine, whey, butter, sugar of milk*, and *lactic acid*, in milk; *mucus; horn*, in the epidermis, hair, and nails; *fibrine* in the blood, lymph, chyle, and muscles; *albumen* in serum, in the substance of the brain and nerves, in the muscles, the synovia, the

lymphs, the fluids of the eye, and the ear wax; *fatty substances*, either separate in the cellular tissue and the cavities of bones, or united with other matters, as in chyle, in the brain, in milk, bile, &c.; *osmazome*, the substance to which the peculiar smell and taste of roasted meat is due; *jelly; hæmatine* (coloring matter of the blood); *pigmentum nigrum* in the eye, the skin of negroes, &c., &c.

The elements of the body, as above enumerated, are combined into various tissues, of which the following are those most generally distinguished: *dermoid; cartilaginous; fibro-cartilaginous; fibrous; nervous; osseous; cellular; adipose; vascular; muscular; erectile; mucous; serous; glandular.* These various tissues, whose combination constitutes the various organs of the body, will be treated of more fully hereafter. The explanation of the cellular tissue, however, may here find its most appropriate place. This consists of a soft transparent substance, capable of being drawn out into threads, and forming sheets or fascia, in many places rendered opake by a closely compacted web of vascular tissue. It is found beneath the skin; between the different muscles, and even separating their finest fibres; investing, and in part constituting, various organs; in fact there is scarcely any part of the body in which it may not be detected. It is eminently characterized by the presence of cellular cavities, which appear to communicate freely with one another, and thus permit the ready passage of fluids.

5. Arrangement of Special Systematic Anatomy.

The problem in Systematic Anatomy is to describe the highly various parts of the human body, in such order of succession as shall correspond most nearly to their actual combinations, and most clearly exhibit their various relations and functions. The arrangement which we have fixed on as answering the necessary conditions supposes six general heads, as follows:

1. The Bones (*Osteology*). This has reference to the structure of the central firm basis of the body, the *osseous system*, a framework inclosed by soft parts, and furnishing cavities which embrace the more delicate organs, as well as constituting a series of levers and fulcra, by means of which the muscles are enabled to bring about extensive and rapid as well as delicate motions.

2. The Ligaments (*Syndesmology*). This includes those parts of the body by means of which the individual bones are so connected together as to permit of relative motions through the agency of the muscles. These two departments are usually treated of under one head.

3. The Muscles (*Myology*). This embraces the muscular system (with its tendons, aponeuroses, and bursæ mucosæ), which operates actively by means of its contractibility, in producing motions in the passive skeleton with its ligaments.

4. The Vessels (*Angeiology*). These consist of the arborescent or reticulated tubes or channels distributed throughout the body, in which the

fluids necessary to life, as the blood, the lymph, and the chyle, are kept in constant movement. They include arteries, veins, and lymphatics.

5. The Nerves (*Neurology*). Under this head we treat of the nervous system, a series of tubular sheaths filled with a whitish matter, and united in larger or smaller bundles, which traverse the entire body, proceeding from a central organ of great development, the brain and spinal marrow. Of nerves we distinguish two kinds: the one conveying impressions from the outer world to the central organs (*nerves of sensation*); the other serving as the medium for the transmission of volitions (*nerves of motion*).

6. The Viscera (*Splanchnology*). This subject embraces various complicated organs, adapted to special purposes. Thus, in the head and neck there are the organs of sight, of hearing, of smell, of taste, and of voice; in the thorax, we have the respiratory organs (*the lungs*), with the thymus and thyroid glands; in the abdominal cavity, the apparatus of digestion (*chylopoietic viscera*), the urinary apparatus (*uropoietic viscera*), and the organs of generation.

I. ANATOMY OF THE BONES AND LIGAMENTS.

(OSTEOLOGY AND SYNDESMOLOGY.)

1. Articulations of the Human Skeleton.

The bones are those hard, compact, and inflexible portions of the body which are inclosed by the muscles, and are united together by ligaments and other modes of attachment into the *skeleton*. This union may be of such a nature as to permit of little or no relative motion of the two contiguous bones; or, on the other hand, such motion may readily take place by means of synovial joints.

We therefore distinguish two kinds of union among bones, each having various subdivisions, which we shall now proceed briefly to enumerate.

A. Synarthrosis. The essential characters of this kind of articulation are: 1. That they are very limited in their motions, so as by some to be considered as immovable; 2. That their surfaces are continuous, or without the intervention of a synovial cavity, but with that of some structure different from bone. The principal varieties are as follows:

a. Sutura. This may be either true (*vera*), as when the margins of two contiguous bones are mutually interlocked in each other, or false (*notha*), where the bones are in juxtaposition by plane but rough surfaces. Sutura vera may be either *dentata*, when the processes are long and dentiform, as in the inter-parietal suture of the human cranium; *serrata*, when the indentations or processes are small and fine like the teeth of a saw, as in the suture between the two portions of the frontal bone; *limbosa*, when, together with the dentated margins, there is a bevelment, so that one edge rests on the other, as in the occipito-parietal suture. Of sutura notha there

are two kinds, *squamosa*, when the bevelled edge of one overlaps and rests on the other, as in the temporo-parietal suture; and *harmonia*, where there is simple apposition, as seen in the union of most bones of the face.

b. Schindylesis. This second form of synarthrosis is where a thin plate of bone is received into a space or cleft formed by the separation of two laminæ of another bone, as seen in the insertion of the azygos process of the sphenoid bone into the fissure on the superior margin of the vomer.

c. Gomphosis. Here one bone is inserted into a cavity in another, just as a nail is driven into a board, or a tree implanted by its roots in the ground. The sole instance in the human subject is seen in the insertion of the teeth in the alveoli or sockets.

d. Amphiarthrosis. This is an articulation where two plane or mutually adapted surfaces are held together by a cartilaginous or fibro-cartilaginous lamina of considerable thickness, as well as by external ligaments. By reason of the elasticity of the interposed lamina, the joint possesses a manifest though slight degree of motion. Examples of this form of joint are found in the articulations between the bodies of the vertebæ, that between the two bones of the pubes, and that between the ilium and sacrum.

B. Diarthrosis. Evident mobility is the distinguishing characteristic of this class of joints; the articular surfaces are contiguous, each covered by a lamina of cartilage (diarthrodal cartilage) having either one or two synovial sacs interposed. The integrity of the articulation is maintained by ligaments which pass from one bone to the other. The varieties are as follows:

a. Arthrodia. Here the surfaces are plane, or nearly so: the motion is that of gliding, limited in extent and direction only by the ligament of the joint or by processes of the bones. Examples are seen in the articular processes of the vertebræ, in the radial, the carpal, the sterno-clavicular, and other joints.

b. Enarthrosis. This, sometimes termed a *ball and socket joint*, is where the globular head of one bone plays in a cup-like cavity of another, or others. The ball is kept in place by a capsular ligament. Sometimes there passes a straight ligament from the head of the ball to be inserted into the bottom of the socket. An instance of this is seen in the attachment of the thigh bone to the pelvis. The shoulder affords a second instance of the ball and socket joint.

c. Ginglymus or *hinge joint.* Here the articular surfaces are marked with elevations and depressions, which exactly fit into each other, so as to restrict motion in all but one line of direction. They are always provided with strong lateral ligaments, which are the chief bonds of union of the articular surfaces. Perfect examples of this articulation are furnished by the elbow and ankle joints. The knee also, and the phalangeal joints, are true ginglymi.

d. Trecharthrosis. A pivot and a ring constitute the mechanism of this form of joint. The ring is generally formed partly of bone and partly of ligament; it sometimes moves on the pivot, and sometimes the pivot moves in it. The motion is confined to rotation, the axis of which is the axis of

the pivot. The best illustration of this articulation in the human subject is that between the atlas and odontoid process of the axis or vertebra dentata. Another example is seen in the superior radio-ulnar articulation.

The ligaments which tie the bones together are of two kinds, capsular and funicular. The former resemble a bag open at both ends, in which the extremities of the bone forming the joint are included. The latter are simple cords extending from one bone to another; they may be either cylindrical or flattened. They are variously placed; in some instances they are within the capsular ligament, in others on the outer surface, and sometimes so blended with it as not to be separable without an artificial dissection. The attachment of the head of the thigh bone to its socket in the pelvis illustrates the capsular ligament, while that of the tibia to the thigh furnishes an example of the funicular. Cartilages are also found placed between joints for the purpose of diminishing friction. All the movable articulations also have their surfaces covered with a layer of cartilage of the most exquisite smoothness. In addition to this, there is a closed sac called the synovial membrane, lining the articulation and reflected over the inner faces of the capsular ligament and the articular cartilages. This membrane, unlike the capsular ligament, has no opening whatever. Its whole inner surface appears to secrete the oily fluid called synovia, whose object is to give suppleness and lubricity to the joint.

The human skeleton, considered as a whole, may be conveniently divided into head, trunk, and limbs, all together including from 213 to 217 distinct bones.

Projections on the bones either form articulations with other bones, and are known as head, condyle, &c., or they serve for the attachment of muscles and tendons, in which case they become projections, processes, trochanters, crests, lines, spines, ridges, &c. Depressions, cavities, or fissures are for the attachment of muscles, the formation of articulations, or for the passage of vessels and nerves. They are called furrows, impressions, holes, fissures, canals, grooves, notches, &c.

2. Bones of the Head.

Beginning with the head we find a primary division into the bones of the cranium or skull, and bones of the face.

A. *Bones of the Cranium.*

The cranium is composed of eight bones: the os frontis, the os occipitis, the two ossa temporum, two ossa parietalia, the os sphenoides, and the os ethmoides. The first of these, the *os frontis*, or frontal bone, is represented in *pl.* 121, *figs.* 1[1], 4[1], 5[1], and 7, from the anterior surface, *fig.* 8 from the interior, and *pl.* 123, *fig.* 1, from below. It forms the whole anterior and a portion of the superior lateral and inferior walls of the cranium, and may be divided into the frontal, the two orbitar, and the nasal portions. Between the two tables of the bone are to be found certain cavities or cells called frontal sinuses (*pl.* 123, *fig.* 3[5]), lined by a mucous membrane. A median

central line on the outer surface shows the line of union of the two symmetrical halves into which the bone is divided when young (*pl.* 121, *fig.* 7[1]); this line is often replaced, especially in the young, by a suture called the *frontal suture.* The *frontal protuberances* (*fig.* 7[2]) over the eyes mark the centres of ossification in the fœtus: the *superciliary ridges* (*fig.* 7[3]) below these serve for the attachment of the muscle for wrinkling the eyebrows. Nearly in the middle of the upper-orbitar border is a foramen or notch (*fig.* 4[2], 7[6]), the supra-orbitary foramen for the passage of the supra-orbital artery, veins, and nerve. The inner face of the bone is strongly marked by depressions corresponding with the convolutions of the brain, and also caused by impressions of bloodvessels (*fig.* 8[1,2,3]). On its middle exists a vertical ridge becoming more elevated as it approaches the ethmoid bone, and terminating below in the *foramen cœcum* (*fig.* 5[7]), occupied by a process from the great falx of the dura mater as well as by some very small veins. At the exterior angular part of the orbitar process of the frontal bone is a depression for receiving the lachrymal gland and called the *lachrymal fossa* (*pl.* 123, *fig.* 1[3]); on the nasal side there is a smaller depression or a small spine, *fossa* or *spina trochlearis* (*fig.* 1[4]), serving as a pulley for the superior oblique muscle of the eye. Separating the two orbitar processes, is a large notch for receiving the cribriform plate of the ethmoid bone (*fig* 1[1]), and on each side of this are cells (*fig.* 1[5]), which are continuous with those of the ethmoid.

The parietal bones, *ossa parietalia* (*pl.* 121, *fig.* 1[2], *fig.* 4[3], *fig.* 5[2], *fig.* 9, interior surface). These bones are quadrilateral, convex externally, concave internally. They constitute the superior and lateral portions of the middle of the cranium, abutting against each other along its median line. Externally they are smooth, but raised about their middle into the *parietal protuberances*, the centres of ossification; below these protuberances there is an arched, broad, but slightly elevated ridge for the attachment of the temporal fascia and muscle, and continuous with the ridge on the side of the frontal bone. The internal surface is marked by the convolutions of the brain, and also exhibits a number of arborescent furrows produced by the ramifications of the middle artery of the dura mater (*pl.* 121, *fig.* 9[1]). At the inferior posterior corner of the bone there is also a fossa, which is made by the lateral sinus of the dura mater (*fig.* 9[2]).

The occipital bone, *os occipitis* (*pl.* 121, *fig.* 1[3], *fig.* 6[1], *fig.* 17, external surface; *fig.* 18, internal). It forms part of the posterior and inferior walls of the cranium, and when anchylosed with the sphenoid, as is usually the case in advanced age, constitutes the basilar bone, *os basilare.* On the posterior external surface, and half-way between the foramen magnum and the upper angle of the bone, is seen the *occipital protuberance*, from the lower part of which a small vertical ridge is extended towards that foramen. Into this ridge is inserted the ligamentum nuchæ. From either side of the protuberance an arched ridge extends to the lateral angle of the bone, known as the *superior semi-circular ridge* or *line;* in addition to these we see another ridge and various cavities (*fig.* 17[1,2,5,6]) for the attachment of muscles. In the lower section of the bone is the *foramen*

magnum (*pl.* 121, *fig.* 17 [3]), through which pass the medulla oblongata, the vertebral arteries and veins, and the spinal accessory nerves; on each side are seen the condyles (*fig.* 6 [4], 17 [7]) or surfaces of articulation between the head and the vertebral column, constituting a hinge-joint by which the former may be moved backwards and forwards. In a depression behind each condyle is the *posterior condyloid foramen*, which conducts a cervical vein to the lateral sinus. There is likewise the *anterior condyloid foramen* for conducting the hypoglossal nerve to the tongue. On the interior surface, behind the foramen magnum, is seen a rectangular cross (*fig.* 18 [1, 2]), forming at the centre the internal occipital protuberance. To this cross the dura mater is attached, and it also exhibits the impressions of cerebral bloodvessels. In the angles of the cross are seen broad concavities, the two superior of which receive the posterior lobes of the cerebrum, and the two inferior those of the cerebellum (*fig.* 18 [4, 5]).

Anterior to the lower part of the occipital bone, and placed transversely in the middle of the base of the cranium, is the sphenoid bone, *os sphenoideum* (*pl.* 122, *fig.* 6 above, *fig.* 7 below). In the middle of this highly complicated bone is seen the *body* or *centrum*, which is hollow and contains the *sphenoidal sinuses* (*pl.* 123, *fig.* 2 [3], *fig.* 3 [2]), communicating with the nose. A deep depression on the upper surface, bounded anteriorly and posteriorly by projecting spines and ridges, is the *sella turcica* for the reception of the pituitary gland (*pl.* 122, *fig.* 6 [1]). The inferior surface presents a longitudinal rising in the middle called the *sphenoidal* or *azygos process* (*fig.* 7 [1]), for articulation with the vomer. From the upper anterior part of the body arise, one on each side, the *apophyses of Ingrassias*, the *ensiform processes* or *the little wings* (*fig.* 6 [4]), with the bases perforated by the foramen opticum for transmitting the optic nerve with the ophthalmic artery. The two great wings, *alæ magnæ* (*fig.* 7 [3, 4]), arise from the sides of the body by a small irregular base. They present three faces: one anterior, called orbital from its forming part of the orbit; one external, called temporal; and a third turned towards the brain, forming part of the fossa, for containing its middle lobe. Between the great and the small wings is a considerable fissure called *foramen sphenoidale*, or *foramen lacerum superius* (*fig.* 6 [6]), for transmitting the third, fourth, sixth, and first branch of the fifth pairs of nerves and the ophthalmic vein. Below the base of this hole is the *foramen rotundum* (*fig.* 6 [7]) for the passage of the second branch of the fifth pair, and behind the foramen rotundum again, is the *foramen ovale* (*fig.* 6 [8]) for the exit of the third branch of the fifth pair. About two lines behind the foramen ovale is the *foramen spinale* (*fig.* 6 [9]) for transmitting the middle artery of the dura mater.

From the lower part of the two great wings project downwards on each side the two pterygoid processes constituting the posterior portion of the mouth (*fig.* 6 [7]). They serve for the attachment of certain muscles, and are pierced at their base by the pterygoid foramen for transmitting the nerve of the same name.

The sphenoid bone articulates above and in front with the vomer, the frontal, ethmoidal, malar, and parietal bones, laterally with the temporal,

behind with the occipital, and by the pterygoid processes with the palatine bones.

Temporal bones, *ossa temporum* (*pl.* 121, *fig.* $1^{4, 12, 13, 14}$; *pl.* 122, *figs.* 8, 9). These bones form portions of the inferior lateral walls and of the base of the cranium. They articulate with the occipital, the parietal, the sphenoid, inferior maxillary, and the malar. Their figure is very irregular, consisting of three portions, the squamous, the petrous, and the mastoid.

The squamous portion (*pl.* 121, *fig.* 1^{4}) is the thin circular and anterior part which forms the inferior portion of the temples. The exterior surface is smooth and slightly convex, the interior is formed into fossæ by the convolutions of the brain. The greater portion of the circumference of the squamous portion is bevelled for articulation with the parietal and sphenoid bones; at the anterior inferior part, however, it is serrated and thicker. On the exterior of this portion is the glenoid cavity (*pl.* 122, *fig.* 8^{4}) for articulating with the lower jaw. The outer margin of this cavity is constituted by the base of the zygomatic process (*fig.* 8^{2}), which extends forwards to join the malar bone.

The mastoid portion (*pl.* 121, *fig.* 1^{12}, *fig.* 8^{7}) is thick and cellular, the upper portion being received between the parietal and occipital bones. The cells known as the mastoid sinuses communicate with the tympanic cavity. We also distinguish a mastoid process for the attachment of the sterno-mastoid and trachelo-mastoid muscles; together with a mastoid foramen, for the passage of a vein into the lateral sinus.

The petrous portion of the temporal bone (*pl.* 121, *fig.* $1^{13, 14}$; *pl.* 123, *fig.* $9^{1, 2}$) is a triangular pyramid, arising from the inner side of the mastoid and squamous portions. In the posterior surface of the petrous bone is the *meatus auditorius internus* (*fig.* 3^{2}), for the transmission of the seventh or auditory and the facial nerve. Between the mastoid and zygomatic processes is the *meatus auditorius externus* (*fig.* 8^{5}), which leads to the tympanum. Its rough lower margin is called the auditory process, and to it is attached the cartilage of the external ear. The styloid process for the attachment of the styloid muscles is seen in *fig.* 9^{3}. Behind the root of this process is the stylo-mastoid foramen, which transmits the facial nerve to the face. The jugular fossa, which is situated within the styloid process and the foramen, is occupied, in conjunction with a similar one in the occipital bone, by the internal jugular vein, and the eighth pair of nerves. Anterior to the lower end of this fossa is the foramen caroticum, through which passes the carotid artery and the upper extremity of the sympathetic nerve. The orifice of the eustachian tube is to be found in the angle between the squamous and petrous parts, within the glenoid foramen.

The ethmoid bone, *os ethmoides* (*pl.* 121, *fig.* 10, from above; *fig.* 11, from below; *fig.* 12, from behind; *fig.* 13, from before; *fig.* 14, from the orbitar side; 15, from the nasal or inner side; *fig.* 16, the septum). This bone is so placed as to fill the vacancy between the orbitar processes of the frontal bone. It is cuboidal, and highly cellular. The only part which looks towards the brain is the cribriform plate, *lamina cribrosa* (*fig.* 10^{2}), with a vertical median ridge or process called the *crista galli* (*figs.* 10, 12, 13, 16^{1}).

This plate is perforated by numerous holes, through which pass the ramifications of the olfactory nerve. The lateral portions of the ethmoid (*pl.* 121, *fig.* 10^{3}) are covered by the frontal bone. That portion of the ethmoid which enters into the orbitar cavity (*fig.* 14^{1}) is called the os planum, or lamina papyracea. The internal or nasal face forms part of the nostril. Between the two halves of the bone, and beneath the cribriform plate, is the nasal lamella, or *lamina perpendicularis* (*fig.* 11^{1}, 12^{2}, 13^{2}), which, in conjunction with the vomer, divides the nasal cavity into halves. In the posterior middle portion of the nasal face is a deep furrow, called *the superior nasal meatus* (*fig.* 15^{2}). The upper margin of this meatus is constituted by the upper turbinated bone, the middle turbinated bone being below.

B. Bones of the Face.

The face is composed of fourteen bones, of which thirteen enter into the composition of the upper jaw. Of these, twelve are in pairs: the ossa maxillaria superiora, ossa malarum, ossa nasi, ossa ungues, ossa turbinata inferiora, ossa palati. The single vomer constitutes the thirteenth, and the os maxillare inferius, or lower jaw, the fourteenth.

Superior maxillary bones, *ossa maxillaria superiora* (*pl.* 121, *figs.* 1^{10}, 4^{10}; *pl.* 123, *fig.* 6). These are the largest of the bones of the face, and occupy the anterior part of the upper jaw. Each consists of a central portion, with various processes for articulation with the contiguous bones. This central portion is hollowed out into a large cavity, called the *antrum highmorianum*, or maxillary sinus, communicating with the cavity of the nose. The superior face is formed by a thin plate, the orbitar process, constituting the floor of the orbit (*pl.* 123, *fig.* 6^{3}). In the posterior part of this plate is a groove, which leads to a canal terminating at the front of the bone in the infra-orbitar foramen (*fig.* 6^{4}; *pl.* 121, *fig.* 4^{9}), through which pass the infra-orbitar nerve and an artery; below this, again, is a depression in the front of the bone (*pl.* 123, *fig.* 6^{6}), known as the *fossa maxillaris*, filled up during life by muscle and fat. The nasal process (*fig.* 6^{1,2}) connects the bone with the frontal and nasal bones, and exhibits an emargination inferiorly and anteriorly (*fig.* 6^{2}), to which is attached the cartilage of the nose. The malar or zygomatic process (*fig.* 6^{7}) connects it with the malar bone. The alveolar processes, for lodging the eight teeth of the adult, are situated in the external inferior portion, and the palatine process (*pl.* 121, *fig.* 6^{12}) constitutes the greater portion of the bony palate. In the suture of the two maxillary bones, and immediately behind the front alveolar processes, we find the *foramen incisivum* (*fig.* 6^{13}), which bifurcates above, sending a branch into each nostril. Through this passes a branch of the spheno-palatine nerve. The intermaxillary bone, so universal in the lower Mammalia, is wanting as a distinct element in the adult man (it being fused with the true maxillary), but in the young fœtus may be distinctly recognised; it rarely exists after birth. The articulations of the maxillary bones are with the frontal, nasal, unguiform, malar, and ethmoid, above; with the palatine, behind; with the vomer, in the middle; and with the inferior spongy bone, by the nasal surface.

Palate bones, *ossa palati* (*pl.* 123, *fig.* 7, from without; *fig.* 8, from within; and *fig.* 9, from behind). These bones, two in number, are placed posterior to the maxillary, between them and the pterygoid processes of the sphenoid. For this reason, they are but slightly conspicuous in the entire skull. The *palate plate* of these bones forms the posterior continuation of the palate process of the superior maxillary in the bony palate (*pl.* 121, *fig.* 6[11]).

The nasal plate, or ascending portion, constitutes the posterior external part of the nostril. The upper extremity is formed by two processes, one anterior, the other posterior; and separated by either a round notch or by a foramen. The posterior of the two is known as the pterygoid apophysis.

The orbitar portion is irregular in shape, and may be seen between the ethmoid and maxillary bones, in the back part of the orbit. The spheno-palatine foramen is the notch between the orbitar portion and the pterygoid apophysis, completed into a foramen by the application of the sphenoid bone. Through this passes the lateral nasal nerve, with the spheno-palatine artery and vein. There are various grooves and canals in the palate bones, which, continuously with corresponding grooves in other bones, transmit vessels and nerves to the soft palate (*pl.* 123, *fig.* 7[1], 9[3]).

The palate bones articulate each with its fellow, on the opposite side of the median plane of the face; also with the upper maxillary, the sphenoid, the ethmoid, the inferior spongy, and the vomer.

The nasal bones, *ossa nasi* (*pl.* 121, *fig.* 1[6]; *fig.* 4[7]; *fig.* 5[6]; *pl.* 123, *fig.* 10, *a*). These bones, two in number, are situated between the nasal processes of the superior maxillaries. They are oblong in shape, and are applied to each other so as to constitute a strong arch, called the bridge of the nose. They also articulate with the frontal bone above.

The unguiform or lachrymal bones, *ossa lachrymalia, ungues* (*pl.* 121, *fig.* 1[7]; *pl.* 123, *fig.* 11). This bone is placed at the internal side of the orbit, and constitutes the nasal duct for the tears, by its application to a process of the inferior turbinated bone.

The inferior spongy bones, *ossa conchæ inferiora* (*pl.* 123, *fig.* 14). This bone is situated at the inferior lateral part of the nose, just below the opening into the maxillary sinus. The anterior extremity rests upon the ridge across the root of the nasal process of the upper maxillary. The posterior extremity rests similarly upon the ridge across the nasal plate of the palate bone.

The vomer or ploughshare, *vomer* (*pl.* 121, *fig.* 6[16]; *pl.* 123, *fig.* 13). This single bone constitutes the lower portion of the bony septum of the nostrils. The superior broader margin has a furrow for receiving the azygos process of the sphenoid bone. The posterior margin is rounded and smooth. The inferior margin articulates with the spine or ridge of the superior maxillary and palate bones.

The cheek or zygomatic bones, *ossa malarum* (*pl.* 121, *fig.* 1[9]; *pl.* 123, *fig.* 12). These bones are situated at the external part of the orbit, and constitute the middle external part of the face. Of the three surfaces, the one which enters into the orbit is known as the internal orbitar process. The front surface is convex and belongs to the bones of the face; the third

surface is concave and forms part of the zygomatic fossa. Of the processes of this bone, the upper one is the superior orbitar. The orbitar margin terminates inferiorly in the inferior orbitar or angular process. The zygomatic process joins the bone with the zygoma of the temporal bone; the maxillary bone forms a fourth angle.

This bone articulates with the maxillary, the frontal, the sphenoidal, and the temporal.

Lower jaw, *maxilla inferior* (*pl.* 123, *figs.* 15, 16). This bone articulates freely with the skull by means of the condyloid processes which play in the glenoid cavity of the temporal bone. It is distinguished into the body and the branches. The body consists usually of two halves, which are separate in the very young individual, and unite at the anterior symphysis. In the adult there are sixteen alveoli or sockets for teeth in the superior margin, and the portion thus occupied possesses somewhat the form of a horse shoe. The symphysis corresponds to the chin, *mentum* (*pl.* 121, *fig.* 1^{11}, *fig.* 4^{13}), on each side of which is the *foramen mentale* (*pl.* 123, *fig.* 15^{2}, *pl.* 121, *fig.* 4^{12}); through this pass blood-vessels and a nerve to the face. On the inner surface, about the middle, is a small spine, *spina mentalis interna*, for the attachment of muscles of the tongue and larynx. The extremities of the lower jaw, *rami*, are quadrilateral, and rise up much above the level of the body. The superior margin of each ramus exhibits a crescentic notch dividing it into two portions. The anterior portion is triangular and slightly curved backwards; to it is attached the temporal muscle, and it is known as the *coronoid process* (*pl.* 123, *fig.* 15^{4}). The posterior border of the notch or concavity is constituted by the condyloid process (*fig.* 15^{3}), the application of which has already been mentioned. On the inside of each ramus is seen the posterior mental foramen (*fig.* 16^{2}), through which pass the inferior maxillary vessels and nerve.

The lower jaw is articulated with the temporal bone in such a manner as to admit of considerable freedom of motion in an antero-posterior and lateral, and still more in a vertical direction (*pl.* 124, *figs.* 1, 2, 3). An inter-articular cartilage is placed in the joint for greater freedom of movement (*fig.* 3^{1}). On each side of this cartilage is a synovial membrane separating it from the two faces of the joint. The external lateral ligament (*fig.* 1^{1}) arises from the inferior margin of the root of the zygomatic process of the temporal bone, and is inserted into the neck of the condyloid process. The internal lateral ligament (*fig.* 2^{1}) arises from the spinous process of the sphenoid bone, and is inserted into the spine bordering the posterior mental foramen. The stylo-maxillary ligament (*figs.* 1, 2, 3^{2}) passes from the external side of the styloid process, and is inserted into the posterior margin of the jaw, near its angle.

C. General Considerations respecting the Head.

The individual bones hitherto considered constitute the head by their apposition, and, as already remarked, are grouped into bones of the cranium, or brain case proper, and bones of the face. The cranium is an ovoidal

case with a flattened base, inclosing a cavity of similar shape, *cavum cranii* (*pl.* 121, *g.* 5), narrowest anteriorly, but wider in the middle than behind. The precise shape of the cranium, however, depends upon that of the brain, and consequently varies with the individual. In the face are found the orbits or cavities for the eyes, those for the nasal apparatus, and the mouth.

The bones of the skull are mostly united by the articulation known as the sutura. The *coronal suture* joins the frontal bone with the two parietal, and extends from one temple to the other across the skull. The *frontal suture* is not always seen, as it usually becomes obliterated with age. When present, however, it extends along the upper median line of the cranium, from the base of the nose to the coronal suture, and divides the two frontal bones. The *sagittal suture* unites the two parietal bones along the median line in the continuation of the frontal suture, and extends from the coronal to the lambdoidal suture. This *lambdoidal suture* unites the occipital to the parietal bones by its upper half, and the occipital to the temporal by the lower. The *squamous suture* unites the temporal to the parietal bones, and occupies the side of the head.

The outer surface of the head may be conveniently divided into four regions. The *superior*, or the *vertex*, is smooth and even, without any remarkable features attending it. The *lateral* regions are each divided into two, the anterior or temporal, and the posterior or mastoid; the meatus auditorius externus is between the two. The *inferior* region extends from the nasal notch in the frontal bone to the occipital protuberance, and is bounded laterally by the zygomatic arches and by a ridge which is continued from these processes around the skull with but little interruption. This region may be divided into three portions, anterior, middle, and posterior. The *anterior* basilar region extends from the superciliary ridges of the frontal bone to the roots of the pterygoid processes of the sphenoid; it presents the nasal spine and process of the os frontis, bounded by their angular processes before and by the orbital plates of the sphenoid behind. In this division are the supra-orbital, the anterior and posterior orbital holes, the openings of the frontal and ethmoidal cells, the optic and lacerated foramina of the orbits, the vidian canals, and the foramina rotunda. The middle division extends from the roots of the pterygoid to the styloid processes of the temporal bones; it presents the azygos process of the sphenoid, the basilar process of the occipital, the anterior points of the petrous portion of the temporal bones, the spinous processes of the sphenoid, and the glenoid cavities of the temporal bones. The foramina, or holes in this division, are the ovale, spinale, carotidum, auditorus externus, and the glenoid; the eustachian canals are external to it. The *posterior* division extends from the styloid processes of the temporal to the tuberosity of the occipital bone; it presents the foramen magnum, the two condyles, the jugular ridges, the styloid processes of the temporal bones, surrounded by the vaginal processes, the mastoid processes, the digastric grooves, the inferior and superior transverse arches, the spines, protuberance, and depressions of the occipital bone. The foramina in this division are the

stylo-mastoid, mastoid, magnum, lacera postica, anterior and posterior condyloid, aqueductus cochleæ, and the tympanic foramina in the petrous bone.

The inside of the skull (*pl.* 121, *fig.* 5) is divided into the arch or vault, and the base. On the vault is seen the sulcus for the longitudinal sinus, the frontal crest, the grooves for the middle arteries of the dura mater, the depressions for the convolutions of the brain and for the granulations or glands of Pacchioni. The base of the skull is very uneven, and presents on each side of the median line three regions or fossæ, on different planes, viz. the anterior or frontal, the middle or spheno-temporal, and the posterior or occipital.

The anterior or *frontal division* is formed of the orbital plates of the frontal bone, the cribriform plate of the ethmoid, and the lesser wings of the sphenoid. The foramina are the cœcum (*fig.* 5 [7]), the olfactory (*fig.* 5 [9]), the internal orbital, and the optic (*fig.* 5 [11]).

The middle or *spheno-temporal division* is bounded before by the lesser wings of the sphenoid bone; on the sides by the squamous portions of the temporal, and behind by the superior angles of the petrous portions of the same bone, and by the posterior clinoid processes of the sphenoid. In the middle is the sella turcica; on each side of, but below this, is a groove for the carotid artery (*fig.* 5 [16]), and below this is a shallow groove for the superior maxillary nerve. Further out on each side are the cavities to lodge the middle lobes of the brain, and on the superior surface of the petrous bones are seen the juttings of the vertical semicircular canals. The foramina in this division are, the *foramina lacera orbitalia superiora*, *rotunda* (*fig.* 5 [14]), *ovalia* (*fig.* 5 [15]), *carotica* (*fig.* 5 [17]), *spinalia* (*fig.* 5 [16]), *lacera basis cranii anteriora*, and *innominata* or *hiatus Fallopii*.

The posterior or *occipital region* is bounded before by the basilar process and by the posterior surface of the petrous bones, and behind by the occipital; it presents the basilar process, the foramen magnum, and the perpendicular ridge of the occipital crossed by the transverse, by which this bone is divided into four fossæ. On the superior angle of each petrous bone is a shallow groove for the superior petrosal sinuses; the transverse occipital ridge presents a deep groove for the lateral sinuses, which last are continued over the inferior angles of the parietal bones, and thence descend inwards along the mastoid portions of the temporal bones, and then again groove the occipital, passing forwards on it to the posterior foramina lacera. The perpendicular ridge is grooved above for the longitudinal sinus, which terminates sometimes in the left, but more frequently in the right lateral sinus. The vertical ridge below the tentorium gives attachment to the falx minor, and is slightly grooved for the occipital sinuses. The foramina in this division are, the *foramina auditoria interiora* (*fig.* 5 [20]), the *aqueductus vestibulorum*, *foramina lacera postica*, *foramen magnum*, *foramina condyloidea antica* (*fig.* 5 [22]), and *postica* (*fig.* 5 [23]).

3. Special Anatomy of the Spine.

A. Bones of the Trunk.

The trunk is constituted by the vertebral column or spine, the thorax, and the pelvis.

The spine, *columna vertebralis*, *rachis* (*pl.* 122, *fig.* 3[1], 4[1,3,6], *fig.* 5, A, B, C), is placed at the posterior part of the trunk, and consists of twenty-eight or twenty-nine pieces. Of these, twenty-four are called true vertebræ, and connected by ligaments so as to form one strong but flexible column. The twenty-fifth piece, reckoning from the head, is the sacrum, and is inserted between the ossa innominata; the remaining three or four constitute the os coccyx, and in their imperfect form represent the caudal vertebræ or tail of other vertebrate animals.

Each vertebra consists of a body, and of several projections or processes. The *body* occupies the anterior central part; it is thick and spongy, and rather circular or oval; its upper and lower surfaces are flat or slightly concave, and give attachment to the inter-vertebral ligaments. The margin of each is tipped with a compact white substance, and the lower surface is rather larger than the upper. Anteriorly it is transversely convex and grooved horizontally, particularly on either side, and is likewise very porous. Posteriorly it is concave, so as to form part of the spinal canal or foramen. This surface is perforated by large foramina for the escape of the venous canals which ramify through the bone. The processes of each vertebra are nine, two lateral or the laminæ, two transverse, four oblique or articulating, and one spinous.

The *lateral processes*, or laminæ, arise one on each side, by a sort of pedicle, from the posterior part of the body; they pass backwards, bounding the sides of the spinal hole, and unite posteriorly in the spinous process; they are broad behind, but narrow where they join the body, being grooved out above and below into a notch. The inferior of these is the larger. The laminæ form the lateral and posterior portions of the spinal arch or foramen for the spinal cord. The roots of these laminæ, or the pedicles, are considered by some as separate portions; they form the common point of support for the other processes, and separate the superior from the inferior notch. These notches, where the vertebræ are joined, form the inter-vertebral holes for the passage of the spinal nerves.

The spinous process is the most projecting part of the vertebra in the posterior median line; its base is bifurcated, and passes into the two laminæ; its apex generally ends in a point or tubercle. The whole series of these processes presents the longitudinal prominent crest posteriorly, named *spine.* Each process receives the insertion of tendons, and serves as a lever for the extensor muscles of the column.

The transverse processes arise from the roots of the laminæ, or rather from the pedicles, and are directed outwards on each side; they serve for the attachment of tendons, and in the dorsal region they also support the ribs.

The articular or *oblique processes* are four in number; they arise from the roots of the transverse processes or from the pedicles; two ascend, two descend. They are covered with cartilage, and articulate with the corresponding processes of the adjacent vertebræ. The two superior are directed more or less backward, and the two inferior more or less forward; their direction is rather vertical or contrary to that of the surface of the bodies, beyond the level of which they extend, so that their articulations correspond to the inter-vertebral ligaments.

The spinal hole or *canal* is bounded by the body and processes; it is more or less triangular.

The vertebræ are divided into three sets, all differing in size and shape. The first set reckoned from below is the *lumbar* (*pl.* 122, *fig.* 5 C), consisting of the five bones immediately above the sacrum and at the lower extremity of the column. They are the largest of all. The *dorsal* (*fig.* 5 B) are twelve in number, and are situated above the lumbar. They are intermediate in size between the lumbar and the cervical. On each side of the body of a dorsal vertebra there is a notch in the upper and lower margin. When two vertebræ are conjoined, the inferior notch of one is in apposition with the superior notch of the vertebra beneath, and the two notches together constitute an oval depression for the head of a rib.

The cervical vertebræ (*fig.* 5 A), seven in number, are the smallest of all, and occupy the top of the column. The first or uppermost of all is called the *atlas* (*pl.* 123, *figs.* 35, 36); it consists merely of a bony ring, without a distinct body or spinous process. The laminæ are thick and round behind, but near the articulating processes they are flattened and grooved above for the vertebral artery and first cervical nerve, and below for the second cervical nerve. Before these notches are the articular processes, which receive the occipital condyles. The second vertebra of the neck is known as *epistropheus* (*fig.* 37). It is remarkable for the depth of its body, from the upper part of which rises a large round dentiform (*odontoid*) process (*fig.* 37 [2]), the fore part of which is received into the small articulating cavity on the anterior arch of the atlas, while posteriorly it presents a small, smooth convexity, which moves against the smooth surface of the transverse ligament of the atlas.

Pl. 123, *fig.* 35, the atlas from above: 1. Superior articular surface for the occipital condyles; 2. Posterior, and 3, anterior arch, with their respective tubercles; 4. Transverse process; 5. Spinal hole.

Fig. 36, the atlas from below: 1. Inferior surfaces for articulating with second cervical vertebra; 2. Articulating surface for the odontoid process of the epistropheus.

Fig. 37, the second cervical vertebra (epistropheus) from behind: [1], the body; [2], odontoid process; [3], superior oblique process; [4], transverse process. *Fig.* 38, the same from the side: [1], body; [2], odontoid process; [3], superior oblique process or articulating surface; [4], transverse process; [5], spinous process.

Fig. 39. A cervical vertebra from above: [1, 2], body; [3], transverse process; [4], oblique process; [5], arch; [6], spinous process.

Pl. 123, *fig.* 40. A dorsal vertebra from the side: [1], body; [2], articulating face for the head of a rib; [3], intervertebral notch; [4], oblique process; [5], transverse process; [6], spinous process.

Fig. 41. A lumbar vertebra from above: [1], transverse process; [2], oblique process; [3], spinous process. *Fig.* 42. The same from the side: [1], inferior oblique process.

The sacrum (*figs.* 43, 44) is a broad flattened triangular bone, concave anteriorly, convex posteriorly, inserted like a wedge between the two ossa innominata, and articulating with the lumbar vertebra above, with the coccyx below. In the young skeleton it is clearly seen to consist of five distinct vertebræ, which become fused together or anchylosed with age, always, however, leaving traces of the original separation, especially on the anterior face. In fact, all the elements of true vertebræ are here present, although in no high condition of development. The upper anterior projecting edge of the sacrum is termed the *promontory*, behind which is the triangular aperture of the sacral or spinal canal. On either side of this canal is the oblique or articular process. The inferior extremity of the sacrum, or the *apex*, is directed downwards, sometimes a little forwards; it presents a small transverse, oval, convex surface, for articulation with the coccyx. The anterior concave surface is marked by four transverse lines (*fig.* 43 [2]), at the extremities of which on each side are four large holes (the *anterior sacral*). These transmit the anterior sacral nerves, veins, and arteries. The posterior surface is roughened by four horizontal eminences in the median line, corresponding with the spinous processes. On each side of this median ridge is a rough groove, in which are four posterior sacral foramina (*fig.* 44 [2]), which transmit the posterior sacral nerves and some bloodvessels. The inferior extremity of the sacral canal is bounded posteriorly by a ligament, and laterally by two tubercles, *cornua sacralia*, which descend to meet similar processes from the coccyx.

The ossa coccygis or *coccyx* (*pl.* 122, *fig.* 31) correspond to the caudal vertebræ of animals. They consist of three or four, rarely of five pieces, which in the young are divisible into three parts, while in the adult they are united into one or two. Considering the combination into one piece, this in the adult is of triangular shape, serving to prolong anteriorly the curve of the sacrum (*fig.* 5 [1]). The *base* above is broad, and bounded by two cornua (*fig.* 31 [1]), which interlock with those of the sacrum.

B. Articulations and Ligaments of the Spine.

Articulation of the head with the spine (*articulus capitis*). This is a double arthrodia, the condyles of the occipital bone being received into the superior oblique processes of the atlas. The motion is quite limited, and restricted almost entirely to a forward and backward movement of the head. The *capsular ligament* on each side arises from the circumference of the condyle, and is inserted into the circumference of the glenoid cavity of the atlas. The interior of each capsule is lined by a synovial membrane. *Anterior and posterior occipito-atlantal ligaments* (*pl.* 124, *fig* 4 [1], *fig.* 5 [1,2])

arise from the edges of the foramen magnum, and are inserted into the upper border of the atlas before and behind its oblique processes. The *lateral ligaments* extend as strong cords from the transverse processes of the occipital bone to those of the atlas.

Between the atlas and occiput, as already remarked, scarcely any motion but that of flexion and extension can occur. The turning of the head, or the horizontal motion, takes place between the first and second vertebræ (the atlas and epistropheus). To this end, the articular extremity of the odontoid process rests on a depression on the posterior border of the anterior arch of the atlas. It is held in this position by a capsular ligament, but for the sake of greater security a strong, straight ligament (the transversal) extends behind it from one side of the atlas to the other. The neck of the odontoid process is thus inclosed in a circular collar, formed by the arch of the atlas in front and the transverse ligament behind, in which it can rotate like a pivot, being held most securely in its place (*pl.* 124, *fig.* 7 [3]). The importance of this ligament is very great; in cases where it has become softened by disease, and ruptured, death has been instantaneous; the head falling forward and the odontoid process projecting backward, has either compressed or pierced the medulla oblongata. An additional security against dislocation is furnished by the moderator or check ligaments, *lig. suspensorium dentis epistrophei* (*fig.* 7 [1, 2]), which arise one from each side of the odontoid process, and are inserted into a depression on the inner side of each occipital condyle. The two ligaments are usually united by a fasciculus which passes above the summit of the odontoid process. In addition we find a ligament, the middle occipito-axoid or *apparatus ligamentosus* (*fig.* 5 [1]), extending from the inner surface of the basilar process of the occipital bone beneath the dura mater, and passing through the foramen occipitale, to be inserted into the superior part of the transverse ligament of the atlas, and below this into the bodies of the second, third, and fourth vertebræ.

In addition to the ligament extending between the head and first and second cervical vertebræ, there are others which either extend continuously along the entire spine, or are repeated between each contiguous pair of vertebræ. These may be distinguished into two sets: those which unite the bodies, and those uniting the processes. The first comprise the anterior and posterior common vertebral ligaments and the intervertebral fibro-cartilages or ligaments; the second set include the capsules and synovial membranes of the oblique processes, the infra-spinous or yellow ligaments, the inter-spinous, the supra-spinous, and the inter-transverse. The bodies of the vertebræ are united by an anterior, a posterior, and an intervertebral ligament.

The anterior vertebral ligament (*pl.* 124, *fig.* 4 [2]) is a strong band of fibres extending from the atlas to the sacrum along the anterior face of the spine, and adhering strongly to the bones, particularly to their edges and to the intervertebral substances. Its object is to attach the vertebræ together, to strengthen the intervertebral ligaments, and to oppose excessive extension of the column.

The posterior vertebral ligament (*pl.* 124, *fig.* 7 [4]), in part a prolongation of the apparatus ligamentosus, extends down the back part of the bodies of the vertebræ, along the front of the spinal canal. It adheres more closely to the edges of the vertebræ and to the intervertebral ligaments than to the middle of each vertebra, and runs out in the sacral canal. Its object is to give strength to the spine by opposing too much flexion of the column.

The intervertebral ligaments (*fig.* 10 [1, 2]) are placed between the bodies of all the vertebræ except of the first and second. They are fibro-cartilages, partaking both of cartilage and ligament in their character. Their union above and below to the flat surfaces of the vertebræ is so intimate, that maceration or boiling alone can separate them completely; and their own strength and cohesion surpass that of even the bones themselves, the bone breaking before the ligament can be ruptured or torn from its attachment. In the neck and loins they are thicker in front than behind, the contrary being the case in the back; this causes much of the peculiar curvature of the spine.

The oblique or articulating processes of the vertebræ are connected by synovial membranes and by ligamentous capsules extending irregularly around these so as to form imperfect capsular ligaments.

The ligamenta subflava (*fig.* 11 [1]) are situated between the back parts of the plates or the arches of the vertebræ; they close the intervals between them, and thus complete the back part of the spinal canal. The name is derived from their yellow color. The *supra-spinous ligament* (fig. 12 [1]) extends in the median line from the occiput to the sacrum, connecting the extremities of the spinous processes. The cervical portion is usually considered as a distinct portion under the name of *ligamentum nuchæ*, attached above to the occipital bone, below to the last cervical spine, and intermediately by distinct slips to all the cervical spines except that of the atlas. The *interspinous ligaments* (*fig.* 12 [2]) are fibrous membranes placed vertically, and filling the space between the spinous process. The *inter-transverse ligaments* are ligamentous fibres extending between the transverse processes.

4. Special Anatomy of the Thorax.

A. Bones of the Thorax.

The thorax is constituted posteriorly by the twelve dorsal vertebræ, laterally by the twelve pairs of ribs, and anteriorly by the costal cartilages and sternum.

The sternum or *breast bone* (*pl.* 122, *fig.* 3, H) is situated in the anterior portion of the thorax, in its median line. The anterior surface is flat or slightly convex, and is marked by transverse lines which indicate an original division into six pieces. Of these lines the two uppermost are most prominent. The posterior surface is smooth and slightly concave. The superior or cervical end is thick and broad, and very concave transversely. In the adult, it consists of three distinct divisions, the upper of

which, having attached to it the clavicle and the first and half of the second rib, is known as the *manubrium*. The middle piece, or *gladiolus*, presents six notches on each side. The inferior extremity is known as the *xiphoid process:* this is thin and cartilaginous, expanded towards the extremity, where it is rounded, pointed, or bifid. There is frequently a perforation in the centre.

The ribs, *costæ* (*pl.* 122, *figs.* 3, 4, and 5), are twelve in number on each side. They extend in an arched manner from the vertebræ towards the sternum, to which the seven superior pairs are attached by separate cartilages. These are the *true* or *vertebro-sternal* ribs. The five inferior pairs do not reach the sternum, but are connected anteriorly with each other and to the cartilages of the last true rib; they are known as *false* or *vertebro-costal* or *asternal* ribs. The two last pairs are sometimes called *floating* or *vertebral ribs.* The length of the ribs gradually increases from the first to the eighth pairs, then diminishes again to the last. The external surface of the body is smooth and convex; the internal is concave. The upper border is round and smooth, and gives attachment to the intercostal muscles. The inferior border is thin and marked with a groove on the inner side; its edges give attachment to the intercostal muscles, while in the groove are lodged the intercostal vessels.

The posterior end of a rib presents a head, neck, and tuberosity. The head is round and divided by a ridge into two articular surfaces, the inferior of which is the larger; these are received into the depressions in the dorsal vertebræ: an interarticular ligament is attached to the middle ridge. The head is supported by the neck, which lies in front of the transverse process, to which its posterior surface is connected by a ligament. Beyond or external to the neck is the tubercle, which looks backwards and downwards, and is divided into two portions. Of these, the internal is smooth for articulation with the transverse process of the inferior of the two vertebræ, to whose bodies the head of the rib is connected. The external is rough for the insertion of a ligament.

The cartilages which connect the ribs with the sternum must be considered as part of the skeleton. They are twelve in number on each side, and of nearly the same form as the shafts of the ribs. They serve to give great strength and elasticity to the thorax, and permit the free play required by the lungs and heart.

B. Articulations and Ligaments of the Thorax.

The head of each rib is secured to the vertebræ by an anterior or stellate ligament, an interarticular, and two synovial membranes. The tubercle is secured in its socket by a synovial membrane, and by an external posterior and an anterior or internal costo-transverse ligament.

The capsular, stellate, or *anterior ligament* (*pl.* 125, *fig.* 1²) arises from the front of the head of the rib, and thence extends over the two synovial membranes in a radiated manner, and is inserted by three bands, one into the sides of the vertebræ above and below, and the third into the intervertebral substance. The *interarticular ligament* (*fig.* 1³) arises from the

projecting ridge on the articular surface of the rib, and is inserted into the cavity in the intervertebral substance into which the head is received; it separates the two synovial membranes.

In respect to the attachments of the tubercle, the *external* or *posterior costo-transverse ligament* (*pl.* 125, *fig.* 2 [2]) arises from the posterior surface of the extremity of the transverse process; passes outwards and is inserted into the rough, non-articular portion of the tubercle of the corresponding rib. It exists on all the ribs. The *middle costo-transverse ligament* (*fig.* 2 [3]) connects the back part of the rib with the front of the corresponding transverse process. The *anterior* or *internal* costo-transverse ligament (*fig.* 2 [4]), wanting in the first and twelfth ribs, arises from the lower border of the transverse process, and is inserted into the crest on the upper edge of the rib beneath.

The cartilages of the ribs at their costal ends are convex, and are very closely united to the concave surfaces in the extremities of the bones by a sort of gomphosis. The articular ends of the cartilages are attached to the sternum by radiating ligaments, known as *anterior*, *posterior*, *superior*, and *inferior sterno-costal* (*pl.* 124, *fig.* 14 [2], and *pl.* 125, *fig.* 3).

5. Special Anatomy of the Superior Extremities.

A. *Bones of the Superior Extremities.*

Each superior extremity consists of the shoulder, arm, forearm, wrist, and hand: the whole limb comprises thirty-two bones, the sesamoid not included. The shoulder is composed of the clavicle and scapula; the arm, of the humerus; the forearm, of the radius and ulna; the carpus, or wrist, of the eight small carpal bones; and the hand, of five metacarpal and fourteen phalangeal bones.

The clavicle, or *collar bone* (*pl.* 122, *fig.* 3 [1]), is a long bone extending from the summit of the sternum obliquely across the first rib, upwards, backwards, and outwards to the acromion process of the scapula. It is curved like an italic *f*, and presents two extremities and a body or shaft. The sternal end is a thick, triangular, articulating surface, with the circumference roughened for the attachment of ligaments. The body is rounded in the middle and flattened towards the extremities. The acromial end is rough above and below, and at its termination presents a small articulating surface for the acromion scapulæ. The clavicle serves to support the scapula, and to prevent it from falling too far forwards or inwards; it serves as a fixed point for certain muscles, and it protects the vessels and nerves of the upper extremity.

The scapula, or *shoulder blade* (*figs.* 4 [2], 10, 11, 12), is situated at the upper, lateral, and posterior part of the chest, and extends from the second to the seventh rib. It is irregularly flat and triangular, presenting an internal and external surface, three edges, and three angles. The internal or anterior surface (*fig.* 11) is slightly concave, and divided by three or four prominent lines into several broad grooves filled by the fasci-

culi of the subscapular muscle. Above and below these is a smooth flat surface for the attachment of the serratus magnus. The external or posterior surface or dorsum (*pl.* 122, *fig.* 10) is convex, and divided into two unequal parts by a ridge or spine (*fig.* 10^2). This spine, arising gradually from the margin of the scapula, increases in height as it proceeds forward, and becoming flattened above and below. It terminates in an eminence named the acromion process (*fig.* 10^3). The external surface of this process is roughened, while near the apex is seen the articulation with the clavicle. Above the spine is the supra-spinatus fossa, filled by the supra-spinous muscle. The infra-spinatus fossa, below the spine, is larger. In the superior border or costa of the scapula is seen a notch, the *supra-scapular* (*fig.* 10^6), converted into a foramen by ligaments; through this passes the supra-scapular nerve. From the anterior part of this border, in front of the notch, there arises the coracoid process (*figs.* 10^5, 11^3); this overhangs the upper and inner part of the glenoid cavity. The base of the scapula, or the posterior border, is the longest margin of the bone. The anterior, inferior, external, or axillary costa (*fig.* 12^1) leads from the glenoid cavity, this being situated at the convergence of the two costæ. The glenoid cavity (*fig.* 12^2) is supported on a contracted neck; it consists of a shallow concavity, in which plays the head of the humerus. In life or the fresh subject, this cavity is deepened by the fibrous glenoid ligament.

The arm is composed solely of the *humerus* or *brachium* (*pl.* 122, *fig.* 3 C). It is the longest and largest bone in the upper extremity, and presents a body or shaft, with two extremities. The upper or scapular extremity is the larger, and consists of the head, neck, and two tubercles. The *head* (*fig.* 13) is hemispherical, inclined upwards, inwards, and backwards; it is smooth, and covered with cartilage for articulating with the glenoid cavity of the scapula. The *neck* is the slightly contracted line or furrow round the head; it is roughened for the attachment of the capsular ligament. The *tuberosities* are two, the greater (*fig.* 3^4) and the lesser (*fig.* 3^5). Between these tubercles is the deep groove for the long tendon of the biceps muscle. The *body* or *shaft* of the humerus is thick and round above, twisted in the middle, expanded and somewhat triangular below. The lower extremity of the humerus (*fig.* 14) is flattened, elongated transversely, and twisted a little forwards. It presents internally the *internal condyle* (*fig.* 3^6), which is very prominent; externally is the *external condyle* (*fig.* 3^7), not so prominent as the internal, and situated lower down. Between and below these condyles is a series of articulating eminences and depressions, partly turned forwards: they consist externally of a small round head of the radius, internal to which is a slight depression, corresponding to the margin of the radius. Internal to this is a sharp semicircular ridge, extending round the lower end of the bone, separating the radius and ulna. Next comes the *trochlea*, for articulation with the ulna. At the anterior extremity of this trochlea is a depression for the reception of the coronoid process, and at the posterior is another, for receiving the olecranon process of the ulna. The bone between these two depressions is thin and transparent, and sometimes deficient by absorption.

The forearm (*pl.* 122, *fig.* 3, D) is composed of the ulna and radius. Of these, the ulna or *cubitus* (*figs.* 3[9], 15[1]) is situated at the inner side of the forearm, forming the principal part of the elbow; it does not directly enter into the wrist joint, but falls a little short of it below; it is divided into the body and two extremities. The upper extremity is the larger, and presents two processes and an intervening cavity. The posterior process, or the *olecranon* (*figs.* 16, 17, and 18), is the highest part of the bone: posteriorly it is smooth; anteriorly it is also smooth, and covered with cartilage. The *coronoid process* (*fig.* 17[2]) is anterior and inferior to the preceding. Externally it is hollowed out into the *lesser sigmoid cavity* (*fig.* 17[3]) which receives the head of the radius; superiorly it leads into the *great sigmoid cavity* (*fig.* 16[1]) which moves on the trochlea of the humerus in flexion and extension of the forearm; the profile of this cavity resembles the letter C. The lower or carpal end (*fig.* 21[1, 2]) is small and round, with two eminences. The external is named the *head;* it is round, and covered with cartilage, and received into the cavity in the inner border of the radius. The internal eminence, or *styloid process* (*fig.* 21[2]), is more prominent, and on a level with the posterior surface of the bone. The ulna articulates above with the humerus and radius, and below with the radius and interarticular cartilage.

The radius (*figs.* 3[8], 15[2]) is shorter than the ulna, and, while only accessory as a rotating bone in the elbow, it is the principal bone in the carpal joint. It is divided into the body and two extremities. The upper or humeral end presents a head, neck, and tubercle. The head (*fig.* 19[1]) is a circular superficial cavity, with the surface and circumference covered with cartilage, the former to articulate with the small head of the humerus, the latter with the sigmoid cavity of the ulna and with the annular ligament. The neck (*fig.* 19[2]) is nearly an inch long, descends obliquely inwards, and is contracted and circular. At its lower extremity, where it joins the shaft, is the *tubercle* (*fig.* 19[3]). The *body* or shaft is somewhat triangular, and presents three surfaces, separated by three margins or angles. The lower or carpal end of the radius is irregularly square; its anterior prominent edge gives attachment to the anterior carpal ligament. Posteriorly there are seen three grooves: one nearly in the middle line, the second at the ulnar side of this, and the third on the radial side. The styloid process is the inferior extremity of the radius; from its point arises the external lateral ligament of the wrist.

The hand (*pl.* 122, *fig.* 3 E; *pl.* 123, *figs.* 46 and 47) consists of the carpus, metacarpus, and phalanges; twenty-seven bones in all.

The carpus is composed of eight bones, arranged in two rows: the first row consists of the scaphoid, lunar, cuneiform, and pisiform; the second of the trapezium, trapezoid, magnum, and unciforme; enumerating them from the radial to the ulnar side, or from without inwards.

The scaphoides or *navicular bone* (*pl.* 123, *fig.* 47[1]). This is the largest in the upper row, and is situated at its outer or radial side. It presents four articular surfaces, by which it articulates with the radius, the trapezium, the trapezoid, the lunar, and the magnum. The *lunare* or *semicircular bone*

(*pl.* 123, *fig.* 47 [2]) is smaller than the scaphoid. It also has four articular surfaces, for articulation with the radius, the os magnum, unciforme, scaphoides, and cuneiforme. The *cuneiforme* or *pyramidal bone* (*fig.* 47 [3]) is wedge-shaped, with the base looking outwards, and articulating with the lunare. Its other articulations are to the unciforme and pisiforme. The *pisiforme* is pea-shaped, and the smallest bone in the carpus, at the upper and inner part of which it is placed. It articulates with the cuneiforme by a small circular surface. The *trapezium* (*fig.* 47 [5]) is the most external of the second row of the carpus; it meets the scaphoid, the trapezoid, and the first and second metacarpal bones. The *trapezoides* (*fig.* 47 [6]) is less in size than the latter; it articulates with the scaphoid, the trapezium, the magnum, and the second metacarpal. The *os magnum* (*fig.* 47 [7]) is the largest bone in the wrist. It supports the second, third, and fourth metacarpal bones, and joins the scaphoid, the lunar, the trapezoid, and the unciform bones. The *unciform bone* (*fig.* 47 [8]) is next in size to the magnum. Situated at the lower and inner part of the carpus, it articulates with the fourth and fifth metacarpal bones; also with the lunar, the magnum, and the cuneiform.

The *metacarpal bones* belong to the class of long bones. They are five in number (*fig.* 46 [2]), and are nearly parallel with each other. All are concave on the palmar surface, convex on the dorsal, and large at each extremity. The posterior or carpal end is of rather irregular figure; the anterior presents a round head. They are articulated anteriorly with the bases of the first phalanges, and are flattened at the sides for the attachment of ligaments.

The *fingers* are composed each of three phalanges, except the thumb, which has but two. The first, or those nearest the carpus, are largest; next come the middle; the third row being the smallest. The posterior convex surface of the last, or ungual phalanx, supports the nail. On the fore part of the articulation between the metacarpal bones and the first phalanx of the thumb, there are generally two small *sesamoid bones.* These, with their analogues occurring in various situations in the body, do not properly belong to the osseous system, being rather accessories to the tendons of muscles.

B. Articulations and Ligaments of the Superior Extremities.

The ligaments of the superior extremities comprise, 1. Those which connect the clavicle with the sternum; 2. Those connecting the clavicle with the scapula; 3. Those proper to the scapula; 4. Those connecting the humerus with the scapula; 5. Those connecting the bones of the elbow joint; 6. Those of the wrist joint with those of the inferior radio-ulnar; 7. Those of the metacarpus; 8. Those of the phalanges of the fingers; 9. Those connecting the metacarpus and the phalanges.

1. Sterno-clavicular Articulation. This articulation (*pl.* 125, *figs.* 8, 9, 19) is arthrodial, and is secured by an anterior, posterior, inferior, and inter-clavicular ligament, as also by an inter-articular cartilage and two synovial membranes.

The *anterior sterno-clavicular ligament* arises from the end of the cla-

vicle, descends inwards, and is inserted into the fore part of the sternum. The *posterior ligament* takes a course behind the joint, parallel to the preceding, and adheres to the joint, resting upon the sterno-hyoid muscle. These two ligaments (*pl.* 125, *fig.* 8[1], *fig.* 9[1]) are so expanded over the joint as to resemble a capsular or orbicular ligament.

The *inferior costo-clavicular* or *rhomboid ligament* (*fig.* 9[5]) passes from the lower surface of the sternal end of the clavicle downwards, forwards, and inwards, and is inserted into the cartilage of the first rib; it closes the angle between it and the clavicle.

The *inter-clavicular ligament* (*fig.* 8[2], *fig.* 9[2]) extends from the posterior surface of one clavicle to the other; its lower border is generally attached to the posterior lip of the sternum. Its office is to connect the clavicles with each other and with the sternum. The *inter-articular cartilage* (*fig.* 9[4]) is nearly circular, very thin, and often perforated in the centre. On each side is a dry synovial membrane.

2. Scapulo-clavicular Articulation. The oval end of the clavicle is connected with that of the acromion process by a plain arthrodial joint, which is secured by a *superior* and an *inferior acromio-clavicular ligament* (*fig.* 10[1]). These are attached to the surfaces of each bone, and being united or continuous both before and behind, the joint may be considered as a strong orbicular ligament. The *coraco-acromial ligament* really consists of two, the *conoid* (*fig.* 10[2]) and the *trapezoid* (*fig.* 10[3]). The former is posterior and the smaller of the two; and while united posteriorly and externally, anteriorly they are very distinct.

3. Proper Ligaments of the Scapula. These are two in number, an anterior and a posterior. The *anterior*, *deltoid*, or *coraco-acromial ligament* (*fig.* 10[4]) arises from the coracoid process, passes upwards, and is inserted into the point of the acromial process. The *posterior* or *coracoid ligament* arises from the superior costa of the scapula behind the notch, passes forwards, and is inserted into the base of the coracoid process; it converts the notch into a foramen. When this ligament is wanting, as is sometimes the case, the notch is completed into a hole by bone.

4. Humero-scapular or Shoulder Articulation. This joint is a ball and socket (*enarthrodia*), with the head of the humerus retained in the glenoid cavity by the capsular, the coraco-humeral or accessory, and the glenoid ligaments, and a synovial membrane.

The *glenoid ligament* adheres to the margin of the glenoid cavity, and deepens the socket for the head of the humerus: it is partly continuous with or derived from the long tendon of the biceps muscle. The *capsular ligament* (*fig.* 10[7]) arises around the head of the scapula, and increasing in size, encircles the head of the humerus, and is inserted into its neck and prolonged on the periosteum. It derives great strength from the tendons of the four capsular muscles which cover and are identified with it. The *coraco-humeral* or *accessory ligament* extends obliquely downwards and outwards from the coracoid process to the anterior part of the great tuberosity. The *synovial membrane* is reflected over the glenoid surface around the glenoid ligament.

5. Humero-cubital Articulation, or the Elbow Joint. In this, one of the most perfect of the ginglymoid or hinge joints, the opposed extremities of the humerus, ulna, and radius mutually receive each other, and are attached together by an external and internal lateral, and by an anterior and posterior ligament. There is no distinct capsular ligament, although the aggregate of these may be considered as such.

The *external lateral ligament* (*pl.* 128, *fig.* 8 [2]) arises from the external condyle, and is inserted into the posterior and external part of the annular ligament of the radius. This ligament is confounded with the tendons of certain muscles. The *internal lateral ligament* (*pl.* 125, *fig.* 15 [1]) arises from the inner condyle, and is inserted in a radiated manner into the inner margin of the great sigmoid cavity of the ulna, between the coronoid and olecranon processes. It adheres to the synovial membrane, and, with the other lateral ligament, strengthens the articulation.

The *anterior ligament* (*fig.* 12 [1]) consists of thin fibres arising chiefly from above the internal condyle and the coronoid depression on the fore part of the humerus. Some are inserted into the annular ligament of the radius, others into the coronoid process, while the remainder are lost on the synovial membrane. The fibres of the *posterior ligament* extend chiefly in a transverse direction from one condyle and one lateral ligament to the other.

The articulations between the radius and ulna are two in number, one superior, another inferior. The shafts of the two bones are also connected by the interosseous ligament (*fig.* 16 [1]). In the superior articulation the head of the radius is received into the lesser sigmoid cavity of the ulna, and is retained in it by the following ligament.

The *annular ligament* (*figs.* 16 [3], 17 [2]) forms about three fourths of a circle, the lesser sigmoid depression completing it. It arises from the anterior, and is inserted into the posterior border of the lesser sigmoid cavity of the ulna. It is lined by the synovial membrane of the joint; it encircles the head and neck of the radius in the same manner as the transverse ligament of the atlas confines the odontoid process of the axis.

The *oblique ligament* arises from the root of the coronoid process of the ulna, and is inserted into the inner side of the radius below its tubercle.

In the inferior radio-ulnar articulation, the round head of the ulna is received into the sigmoid cavity of the radius, and retained in it by a loose synovial membrane or the *sacciform ligament* (*pl.* 126, *fig.* 1 [1]), which is covered before and behind by some ligamentous fibres, forming an imperfect capsule, and passing from the radius to the ulna. The opposed edges of the shafts of both radius and ulna are connected by a thin aponeurosis called the *interosseous membrane* or *ligament* (*pl.* 125, *fig.* 16 [1 2]). It is not made very tense in any position of the limb, and serves to give attachment to muscles.

6. Radio-carpal Articulations, or the Wrist Joint. In this joint, which is of great transverse extent, the lower end of the radius and the inter-articular cartilage form a socket for the scaphoid, lunar, and cuneiform

bones: the two former are received into the radius; the latter corresponds to the fibro-cartilage which separates it from the ulna, and excludes this bone from the joint. The wrist joint is secured by an external and internal lateral, by a posterior and anterior ligament, and by a synovial membrane.

The *external lateral* or *radio-carpal ligament* arises from the styloid process of the radius, and is inserted into the scaphoid bone. The *internal lateral* or *ulno-carpal ligament* arises from the styloid process of the ulna, extends obliquely downwards and forwards, and is inserted into the cuneiform and pisiform bones. The *anterior* and *posterior ligaments* descend from the radius and interarticular cartilage anteriorly and posteriorly, and are inserted into the superior row of the carpus. These two ligaments, with the two lateral, constitute the *capsular ligament* of some authors (*pl.* 126, *figs.* 1[2,3,4], 2[1,2,3]).

7. Articulations of the Bones of the Carpus. The bones of the carpus are arranged in two rows, between which a certain degree of motion takes place, very little, however, between the individual bones in either row. The bones of the first row are connected by *interosseous ligaments*, consisting of dense tissue placed between the upper border of the scaphoid and lunar, and lunar and cuneiform. They range on a level with the carpal convexity of the bones. The *dorsal* and *palmar ligaments* consist of strong bands, which run in different directions from one bone to another. The four bones of the second row of the carpus, like those of the first, are connected by interosseous substance and by dorsal and palmar bands. The bones of the entire carpus are connected with each other by the *annular ligament* which preserves the arched form of the carpus.

8. Articulations between the Carpus and Metacarpus. The five metacarpal bones present two series of articulations, the posterior or carpo-metacarpal, and the anterior or metacarpo-phalangeal. In the former, the carpal ends of the four internal metacarpal are joined to the lower row of the carpus by nearly plane surfaces, and are secured before and behind by transverse and oblique fibrous bands, which cover the synovial membranes and are called *dorsal*, *palmar*, and *interosseous*. Across the upper and lower extremities of the metacarpus pass ligaments (*fig.* 1[8,9]), whose object is to give compactness to the hand.

9. Articulations between the Metacarpus and the Phalanges. These joints are furnished with capsular ligaments and synovial membranes (*figs.* 3, 4, 5) There are also strong lateral ligaments.

6. Special Anatomy of the Inferior Extremities.

A. Bones of the Inferior Extremities.

To the lower extremities belong the pelvis, the thigh, the leg, and the foot, subdivided into the tarsus, metatarsus, and phalanges. The pelvis consists of four bones, the ossa innominata, the sacrum, a bone of the spine, and the coccyx; the thigh of one, the femur; the leg of three, the patella, the tibia, and the fibula; the tarsus of seven, the astragalus, the calcaneum,

cuboid, scaphoid, and three cuneiform; the metatarsus of five, and the toes of fourteen: thirty-two bones in all.

1. The Pelvis (*pl.* 122, *fig.* 3, K K, *pl.* 123, *figs.* 43, 45) is the irregular, circular shaped, bony ring at the lower end of the trunk, formed by the sacrum and coccyx posteriorly, and by the ossa innominata laterally and anteriorly; it contains some of the abdominal viscera and many of the urinary and generative organs; it also supports the spinal column above, and transmits the weight to the thigh bones, on which it rests below. The sacrum and coccyx have already been described. As each os innominatum (*pl.* 122, *fig.* 3, K) is divisible in early life into three bones, the ilium, ischium, and pubes, uniting to form the socket for the head of the thigh bone, we shall first consider these separately, and then as united into one bone, as in the adult.

a. The individual bones of the Pelvis. The *os ilium* (*pl.* 123, *fig.* 43^{6}) is situated at the upper and outer part of the pelvis, and forms that projection commonly called the hip. It is broad, flat, and triangular, the base above bounded by a semicircular crest, which ends before and behind in processes or tubercles named spinous; the apex below forming the upper and outer part of the acetabulum or socket; it may be divided into the body, ala, and processes. The *body* is the inferior narrowed portion; the *ala* is the broad, fan-like, semicircular portion which ascends from the body, inclining outwards and a little forwards; the external surface, or *dorsum*, is rough and irregularly convex and concave, with a considerable concavity above the acetabulum (external ilia fossa) and two curved semicircular lines, a superior and an inferior. The internal surface of the ala is divided into three parts: one, superior and anterior, is the *iliac fossa;* the second forms about the posterior third of the bone; and the third is smooth and small, and is the only portion of the ilium that enters into the side of the true pelvis. It is separated from the iliac fossa by a rounded edge (called the ilio-pectineal line), continuous behind with the promontory of the sacrum, and before with a sharper ridge on the pubes. The processes of the ilium are, first, the *crest* (*pl.* 123, *fig.* 43^{6}), forming the upper border of the ala; second, the *anterior superior spine*, at the anterior extremity of this crest; there is a notch between this and the third process, the *anterior inferior spine.* Internal to this space is a superficial groove, bounded internally by the *ilio-pectineal* eminence, which is common to and formed by the union of the ilium and pubes. Fourth, the *posterior superior spine* is the posterior termination of the crest; and separated from this by a notch is the fifth process, the *posterior inferior spine.*

The *ischium* (*pl.* 122, *fig.* $4^{7,8}$) is placed at the lower, outer, and back part of the pelvis, and presents a body and processes. The *body* forms the outer, lower, and back portion of the acetabulum, constituting more than two fifths of it. The processes are, first, the *spine* (*fig.* 4^{7}), arising from near the middle of the posterior part, below the sacro-sciatic notch. Between this and the second process is the pulley round which the tendon of the obturator muscle turns. This next process is the *tuberosity* or *tuber ischii* (*fig.* 4^{8}). On this rough and broad process the body rests when in

a sitting posture. Between the spine and the tuberosity is the lesser sciatic notch, converted into a foramen by the great sciatic ligament. The third process is the *ramus*, ascending from the tuber forwards and inwards, and joining the descending ramus of the pubes.

The *os pubis* (*pl.* 122, *fig.* 5[3]) is situated at the anterior part of the pelvis, and is smaller than the ilium or ischium. It may be divided into the body and processes. The body is the most external portion, and constitutes the internal and superior part of the acetabulum. From the body the first process, the *horizontal ramus*, proceeds forwards and outwards, grooved beneath where it bounds the obturator foramen. At the internal extremity of this ramus is the second process, the *tuberosity* or *spine*. This is a prominent tubercle, into which Poupart's ligament is inserted. The third process, the *crest*, leads transversely inwards from this spine, and at its internal end is the fourth process, the *symphysis*. From the lower end of the symphysis descends the fifth process, the *inferior* or *descending* ramus; this, with the ramus of the opposite pubes, forms the arch of the pubes; the outer edge of the ramus assists in bounding the thyroid hole.

b. The Pelvis as a whole. Considering in the next place the pelvis as a whole, we commence with the *acetabulum* (*pl.* 123, *fig.* 43[7]), constituted by the junction of the bodies of the three bones. It is surrounded by a prominent border with a deep notch or deficiency internally, and two others of less extent, inferiorly and superiorly. The *great notch* which is opposite the thyroid foramen, between the ischium and pubes, is converted into a foramen by a ligament passing between these two bones. The *cotyloid cavity* (*fig.* 45[2]) in the acetabulum for the reception of the head of the thigh bone, is of a hemispherical form, and about two inches and a half in diameter.

The obturator, or *thyroid foramen*, is situated at the inner side of the acetabulum and at an inferior level, and is the large anterior hole in the pelvis bounded by the ischium and pubes.

The superior circumference or base of the pelvis is formed on each side by the crest of the ilium; posteriorly by the promontory of the sacrum, anteriorly by the iliac spines, ilio-pubal eminences, the intervening grooves, and the crests and symphysis of the pubic bones. The lower or perineal circumference (strait, or outlet, of the pelvis) is directed downwards and a little forwards; bounded by the rami of the pubes, the rami and tuberosities of the ischium, the coccyx, and in the recent state by the sacro-sciatic ligament of each side. When, as in the artificial skeleton, the latter are removed, this strait presents three notches: first, the *arch* of the *pubes*, triangular and placed beneath the symphysis; second and third, the *sacro-sciatic notches* between the sacrum and *os innominatum* of each side. Each of these is divided into a superior and an inferior by the sciatic ligaments.

The internal surface of the pelvis is divided into two parts by the ilio-pectineal line. The upper of these parts, properly part of the abdomen, is known as the *false* pelvis, the inferior being the *true*. The latter is a sort of curved canal, wider about the centre than at either end; with smooth

walls, concave posteriorly from above downwards, concave anteriorly in the transverse direction, and on either side nearly plane.

The female pelvis (*pl.* 123, *fig.* 45) differs from that of the male (*fig.* 43) in several particulars: it is wider and larger, but not so deep; the alæ of the ilium are more expanded, the prominence of the sacrum is less, the inlet and outlet are rounder and wider, the sacrum is broader and more concave, the pubic arch more round and open, the symphysis pubis not so deep, the obturator holes are smaller and more triangular, the sciatic tuberosities are directed more outwards, and the acetabula are more distant from each other; all the bones are more thin and delicate. The male pelvis is deeper, narrower, and the bones more solid and strong. The peculiarities in the female pelvis are intimately connected with the functions of parturition.

2. THE THIGH. This is constituted by but one bone, the *femur* (*pl.* 122, *fig.* 3 L). This is the longest and strongest bone in the skeleton, and is proportionally longer in man than in any other animal; from the pelvis it is directed obliquely downwards and inwards, this obliquity being greater in the female than in the male. It consists of the body or shaft, and two extremities.

The *body* is slightly twisted, very broad below, and with a rough projecting ridge down the posterior face called the *linea aspera* (*fig.* 4^{11}). This divides into two ridges at either end, and above its middle may be seen one or two holes entering obliquely upwards for transmitting the nutritive vessels of the bone.

The *upper* or *pelvic extremity* of the femur presents three eminences, the head for articulating with the cotyloid cavity, and the trochanters for the insertion of muscles.

The *head* (*figs.* 3^{18}, 24) is of a globular figure, and forms a considerable segment of a sphere; it is directed upwards, inwards, and a little forwards; a little below its centre there is a rough oval depression for the insertion of the round or articular ligament. Excepting this depression, the head is covered throughout with cartilage; it is supported by a strong elongated process of a pyramidal form, the *neck* (*fig.* 24), which forms an angle more or less obtuse with the shaft of the bone. A rough irregular line separates the head from the neck, beyond which the articular cartilage of the foramen does not extend. The *great trochanter* (*fig.* 3^{19}) is continuous with the external side of the shaft, and nearly in a line with its axis. It is thick, rough, and square; broad and convex externally. Internally it presents a pit, or digital cavity, which receives the tendons of the external rotators of the limb. The *lesser trochanter* (*fig.* 3^{21}) is a conical tubercle at the posterior and inner side of the shaft, much below the level of the great trochanter and of the base of the neck.

The inferior or tibial end of the *femur* (*fig.* 25) is very large and broad, flattened before and behind, and divided into two eminences or *condyles*, which are separated posteriorly by a deep notch. The condyles articulate with the tibia. The *external* (*figs.* 3^{24}, 4^{14}) is larger, and projects more forward than the internal; its articulating surface also is

broader and ascends higher. An external tuberosity gives attachment to the external lateral ligaments of the knee-joint. Beneath it is a groove which receives the tendon of the poplitæus muscle when the joint is flexed. The *internal* condyle (*pl.* 122, *figs.* 3[23], 4[13]) is narrower, less prominent before, but more prolonged behind. On its inner side is the tubercle for the attachment of the internal lateral ligament. The posterior crucial ligament is attached to the rough outer side. Posteriorly the condyles are separated by a deep fossa or intercondyloid notch which lodges the crucial ligaments. Anteriorly they unite in a trochlea or pulley on which the patella moves. The femur thus articulates superiorly with the pelvis, anteriorly with the patella, and inferiorly with the tibia.

3. The Leg. The bones of the leg are the patella, tibia, and fibula.

The *patella*, *rotula*, or knee-pan (*figs.* 3[22], 5[4], 22, 23) is a small bone in front of the knee-joint, triangular or heart-shaped, the base above, the apex below. The anterior surface is convex and rough, the posterior covered by cartilage and divided by a vertical ridge into two parts. The patella slides in the trochlea of the femur; to the upper end the extensor tendons are attached, while the lower is connected with the tibia by a powerful ligament.

The *tibia*, or shinbone (*fig.* 3, M), next to the femur, is the longest bone in the skeleton. It occupies the anterior and inner part of the leg; the direction, unlike that of the femur, is vertical, and the tibiæ of the opposite sides are parallel. The upper extremity is thick, and expanded from side to side; the circumference somewhat circular or oval, convex in front and on the sides, but slightly grooved behind. The upper or femoral surface (*fig.* 26) presents two condyles, or rather glenoid cavities, for articulating with the femur. The internal is oval, and the deeper of the two; it is also larger antero-posteriorly. The external is nearly circular, and very superficial. The two are separated by a spine, which is of a pyramidal form, and is surmounted by two tubercles; in and about the spine are inserted the semi-lunar cartilages and the crucial ligaments.

The body or shaft of the tibia is triangular; its size diminishes from the head for about two thirds down; it then increases somewhat towards the lower end.

The lower or tarsal end (*fig.* 27) is somewhat square, with an anterior convex edge, covered by extensor tendons; a posterior nearly smooth edge, traversed by a groove; externally a concave triangular surface, smooth below for receiving the lower end of the fibula; internally there is a thick flattened perpendicular process, called the *internal malleolus* or *ankle* (*fig.* 4[17]).

The *fibula* (*fig.* 3[26, 27]) is very slender, and nearly as long as the tibia; it is placed at the outer side of the leg, nearly vertical, with its lower end inclined a little forwards; the superior or femoral end is small and circular, with a slight cavity forwards, upwards, and inwards, for articulating with the tuberosity on the external condyle of the tibia; the lower or tarsal end is larger than the upper; it is elongated into a long oval process, the *external malleolus* or *ankle* (*fig.* 4[18]); the external lateral ligament arises from the point of this process.

4. The Foot is composed of twenty-six bones, which are arranged in three parts, the tarsus, metatarsus, and toes. The bones of the *tarsus* (*pl.* 122, *figs.* 28, 29, 3 [30]; *pl.* 123, *figs.* 48 and 49) are seven: astragalus, calcaneum, navicular, cuboid, and three cuneiform (internal, middle, and external). These are arranged in two rows, the first embracing the astragalus, os calcis, or calcaneum; the second row consists of five bones: the cuboid bone forms it externally alone, but on the inner side it presents two short transverse rows, the navicular forming the posterior, and the three cuneiform bones the anterior.

The *astragalus* (*pl.* 123, *fig.* 48 [1]) comes next to the calcaneum in point of size, and is situated at the upper and middle part of the tarsus, where it is wedged between the two malleoli; superiorly it articulates with the tibia, inferiorly with the calcaneum, anteriorly with the scaphoid, and externally with the fibula.

The *calcaneum* or *os calcis* (*fig.* 49 [2]) is the largest bone in the tarsus, at the lower and posterior part of which it is placed: it is elongated posteriorly into a process called the *heel;* its upper surface presents two articulating surfaces, the support of the astragalus; the anterior extremity presents an articular surface for the cuboid bone; the posterior extremity is roughened below, for the attachment of the tendo Achillis; the inferior surface presents two tubercles, for the attachment of muscles and ligaments: externally it is flat, and marked with two shallow grooves, separated by a spine; internally it is broad, and hollowed out into an arch, through which pass various nerves, vessels, and tendons.

The *navicular* or *scaphoid bone* (*fig.* 48 [3]) is situated about the middle of the tarsus, and at its upper and internal part; of an oval form, its long axis directed downwards and forwards: the posterior surface forms a superficial glenoid cavity, for the head of the astragalus; the anterior surface is convex, and divided by two vertical ridges into three surfaces, for the three cuneiform bones; on the external side there is usually a small flat articular surface, for the cuboid bone; the scaphoid is connected to the calcaneum by a strong ligament.

The *cuboid bone* (*fig.* 48 [7]) is situated at the outer and anterior part of the tarsus, external to the navicular, and anterior to the calcaneum; it articulates posteriorly with the calcaneum, internally with the scaphoid and the external cuneiform, and anteriorly with the fourth and fifth, or the two external metatarsal bones.

The three wedge-shaped *cuneiform bones* (*fig.* 48 [4, 5, 6]) are situated at the anterior part of the tarsus, between the scaphoid and the three internal metatarsal bones: the first or internal is the largest, and the middle the smallest; the first articulates with the scaphoid, the second metatarsal, and the second cuneiform; the second also articulates behind with the scaphoid, before with the second metatarsal; the third articulates anteriorly with the third metatarsal, posteriorly with the scaphoid, internally with the middle cuneiform and with the second metatarsal, and externally with the cuboid and with the fourth metatarsal.

The *metatarsus* (*fig.* 48 [8]) consists of five long bones, parallel, and sepa-

rated by interosseous spaces: its posterior border is connected to the tarsus by an irregular transverse line of articulation; convex forwards, concave backwards. The first or internal of these bones is shortest and thickest; its anterior end supports the great toe. The second is the longest; its tarsal end is articulated to the three cuneiform bones. The third is a little shorter than the second; its base rests on the third cuneiform bone. The fourth is still shorter; it rests on the cuboid bone, and touches the third cuneiform. The fifth is shortest, excepting the first; it rests on the cuboid bone, with a styloid process externally for the insertion of a muscle. The heads of all the metatarsal bones are round, the bases flat and somewhat square, to articulate with the tarsus; the sides of the bases also are flat, to join one another.

The *toes* (*pl.* 123, *fig.* $49^{9, 10, 11}$) are five in number: the first or great toe has only two phalanges; all the rest have three, making fourteen phalanges in all. The first phalanges are longest; the second are very short; the third, also, are very small. At the base of the first phalanx of the great toe there are usually two *sesamoid bones*, over which the small muscles of this toe glide; the sesamoid bones may also occur in some of the other toes.

B. Articulations and Ligaments of the Inferior Extremities.

1. Articulation between the Pelvis and the Spine. The last lumbar vertebra is joined to the sacrum in the same manner as the other vertebræ are joined to each other, by an intervertebral, anterior and posterior, yellow, supra, and interspinous synovial membranes, and capsular ligaments. The connexion is also strengthened by the *lumbo-sacral ligament*, a short, thick, fibrous band, extending from the transverse process of the last lumbar vertebra to the posterior part of the base of the sacrum.

The two last lumbar vertebræ are connected with the ilium by the *ilio-lumbar ligament* (*pl.* 125, *figs.* 4^{4}, $5^{3, 4}$). This is sometimes divided into two; it arises from the transverse processes of the fifth and fourth lumbar vertebræ, and from the back part of the sacrum, and is inserted into the posterior superior spine of the ilium, and into its crest.

The articulations of the pelvic bones with each other are the sacro-coccygeal, the sacro-iliac, the sacro-sciatic, and the pubic. There are no perfect or true joints between the pelvic bones.

The sacrum and coccyx are joined by a thin *anterior*, and a thick *posterior sacro-coccygean ligament* (*figs.* 4^{3}, 5^{2}), as also by a thin intervertebral fibro-cartilage. The articulation usually allows of more motion in the female than the male.

The sacro-iliac articulation is secured by an anterior and posterior ligament. The *anterior sacro-iliac ligament* (*fig.* 4^{6}) is thin, and consists of fibres passing transversely from one bone to another; the *posterior* (*fig.* 5^{6}) consists of fasciculi passing from the rough surface of the sacrum to that of the ilium, and to its posterior superior spine. The *sacro-iliac symphysis* connects the articular surface of these bones, which in the aged are sometimes anchylosed.

The sacrum and ischium, though not in contact, are connected by very

strong and important ligaments. The *posterior* or *great sacro-sciatic ligament* (*pl.* 125, *fig.* 5 [6]) arises from the lower and back part of the posterior inferior spine of the ilium, and from the back part of the sacrum and coccyx; it is inserted into the lower and inner edge of the tuber ischii, and by a falciform process into the ramus of the ischium. By its upper border it converts the lesser sciatic notch into a foramen, and by its lower it completes the posterior and lateral boundary of the lower opening of the pelvis on each side. The *anterior* or *lesser sacro-sciatic ligament* (*fig.* 5 [7]) crosses in front of the former; it arises from the side of the sacrum and coccyx, and is inserted into the spine of the ischium. It separates the two sciatic foramina.

The *symphysis pubis* (*fig.* 7) connects the vertical oval surfaces of the ossa pubis. It is covered in front by a thick fibrous tissue, called the *anterior pubic ligament;* the *superior* and *posterior pubic ligaments* strengthen it superiorly and posteriorly; the *sub-pubic ligament* is situated beneath the symphysis.

2. The Ilio-Femoral Articulation, or the Hip Joint (*pl.* 126, *figs.* 6 and 7). This is the strongest and most perfect enarthrodial, or ball and socket joint, in the system. It includes the head of the femur and the acetabulum, both of which are incrusted with cartilage, and is secured by a capsular and an accessory ligament, a synovial membrane, an inter-articular, cotyloid, and a transverse ligament.

The *ilio-femoral capsular ligament* arises from the os innominatum by a very strong attachment; passes downwards and upwards, incloses the cotyloid ligament, but does not adhere to it except at the notch; enlarges opposite the head of the femur, then becomes flattened and contracted to embrace the cervix, the greater part of which it incloses. Its insertions into the upper part of the femur are partly into the bone, and partly into the periosteum.

The *accessory* or *ilio-femoral ligament* is a strong fibrous band, incorporated with the capsular, arising from and around the spinous process of the ilium, and is inserted into the anterior inter-trochanter line, near the lesser trochanter.

The *synovial membrane* is exposed by dividing the capsular ligament, whose internal surface it lines to some extent.

The *cotyloid ligament* (*fig.* 7 [1]) is the fibro-cartilaginous lip which deepens the acetabulum, and at the same time narrows its orifice, so as to hold the head of the femur even after the capsular ligament and all the muscles have been divided; it fits so tightly around it that the head appears to be retained in the socket partly by atmospheric pressure. The *transverse ligament* consists of ligamentous bands, passing across the notch in the border of the acetabulum, and completing the margin of the cavity.

The inter-articular or round ligament, *ligamentum teres* (*fig.* 7 [3]) arises by two flat bands from the margins of the cotyloid notch, runs upwards, backwards, and outwards, and is inserted into the depression on the head of the femur.

3. The Femoro-tibial Articulation, or the Knee Joint. The con-

dyles of the femur, the head of the tibia, and the patella, enter into this articulation; the fibula is only remotely connected with it. The ligaments which secure it may be classed into those external and those internal to the synovial membrane. The external ligaments are the *ligamentum patellæ*, *ligamentum posticum*, and the internal and external lateral ligaments. The internal are the two crucial, the inter-articular fibro-cartilages, the transverse, and certain folds of the synovial membrance.

The *ligamentum patellæ* (*pl.* 126, *fig.* $8^{1,2}$) consists of strong, parallel, glistening, tendinous fibres which arise from the inferior angle and from the anterior surface of the patella, and are inserted into the tubercles of the tibia. This ligament is principally a continuation of the extensor tendon, in which the patella was developed first in the form of a cartilage.

The *posterior ligament* arises from the tendon of the semi-membranous muscle, and ascends obliquely from behind the inner condyle of the tibia to the external condyle of the femur.

The *internal lateral ligament* (*figs.* 8^{4}, 9^{6}) arises from the back part of the tuberosity on the inner condyle of the femur, below the insertion of the tendon of the abductor magnus; descends obliquely forwards, and is inserted into the internal condyle of the tibia.

The *external lateral ligament* (*figs.* 8^{6}, 9^{7}) arises from the back part of the tuberosity on the external condyle, above the fossa for the poplitæal tendon; it is thick, round, and smooth; descending, it is inserted into the outer side of the head of the fibula.

The *synovial membrane* of the knee is the largest of its class in the body.

The internal ligaments in the knee joint are the alar, mucous, transverse, crucial, and semi-lunar cartilages.

The *alar ligaments* (*fig.* 8^{3}) are only folds of the synovial membrane, in some measure produced by the displacement and eversion of the patella. They are one on each side of the bone, the internal being the most distinct.

The *ligamentum mucosum* or *adiposum* (*fig.* $11^{1,2}$) is only a small fold or tubular process of the same membrane: of a conical form, it arises broad from the fatty substance behind the ligamentum patellæ, passes backwards and upwards, and is inserted into the notch between the condyles. The *transverse ligament* extends between, and is attached to the anterior convex portions of the two semi-lunar cartilages above the articular fatty mass.

The *crucial ligaments* (*fig.* $10^{5,6}$) are the most important of the inter-articular cartilages. They are two strong, twisted, fibrous cords, which pass from the notch in the femur to the median line of the head of the tibia. They cross each other in passing to their respective attachments, this decussation resembling the letter X, whether viewed laterally or before or behind. They serve to attach the femur to the tibia, to steady one bone on the other, and to prevent any lateral displacement.

The *semi-lunar cartilages* (*figs.* $11^{3,4}$, $10^{7,8}$) are placed upon the articular surfaces of the tibia. The convex margin of each is thick, and connected by its edges with the synovial membrane, and between these with the external ligaments and fascia. The anterior and posterior extremities of

each are fibrous, and fixed to the head of the tibia by insertions known as the oblique ligaments. They serve to deepen the articular surfaces of the tibia, and thus to retain the condyles of the femur. They also lessen the effect of concussion in the joint and in the limb generally.

4. Superior Tibio-fibular Articulation. But little motion exists between the tibia and fibula at their superior extremities: the joint is, however, secured by a distinct *synovial membrane*, sometimes communicating with that of the knee joint; there is also a distinct *anterior* and *posterior* ligament, the former of which is the stronger.

5. Inferior Tibio-fibular Articulation. Here the inferior extremity of the fibula is convex, and received into a depression on the tibia: both surfaces are rough superiorly, and covered by cartilage inferiorly: they are connected with each other by a strong *anterior* and *posterior ligament*. The *synovial membrane* is only a small cul de sac continued from that of the ankle joint. Above this is the interosseous ligament, which fastens the bones very closely and firmly together. Very little motion occurs in this joint beyond a slight yielding of one surface against the other.

6. Articulation of the Ankle (*pl.* 126, *figs.* 13, 14). This is the most perfect ginglymoid or hinge joint in the body, excepting that between the ulna and humerus. A deep mortice-like cavity, with an antero-posterior edge, is formed by the lower surface of the tibia, and by the two malleoli. The fibula forms little more than the outer wall of this cavity. In this plays the trochlear surface of the astragalus. The joint is secured by very strong lateral ligaments, also by a synovial membrane and by an anterior ligament.

The *internal lateral* or *deltoid ligament* (*fig.* 14 [4, 5]) arises from the internal malleolus, descends in a radiated manner, and is inserted into the astragalus, navicular, and os calcis.

The *external lateral ligaments* are three, a posterior, middle, and anterior. They all arise from the external malleolus, and are inserted into the astragalus or os calcis (*fig.* 14 [6, 7]).

The *anterior* or *tibio-tarsal ligament* arises from the anterior edge of the tibia and tibio-peroneal ligament, and is inserted into the upper and outer part of the astragalus.

7. Articulation of the Bones of the Tarsus. The seven bones of the tarsus are connected in such a firm and close manner as to admit of little motion between any two except at the articulation between the astragalus and the scaphoid.

The astragalus is connected with the os calcis by a strong interosseous ligament. There are also two synovial membranes. The head of the astragalus fits into the glenoid surface of the scaphoid, in which it enjoys considerable motion. The synovial membrane in the joint is covered superiorly by the *superior astragalo-scaphoid ligament*. Below is the *inferior calceo-scaphoid ligament* (*fig.* 16 [1]) extending from the anterior inferior part of the os calcis to the lower surface of the scaphoid. There is another strong ligament in this joint, called the *superior calceo-scaphoid*. The *inferior* and *superior calceo-cuboid ligaments* (*fig.* 16 [2]), as their name

indicates, unite the calcaneum with the cuboid bone. The union of the scaphoid and cuboid is effected by the *dorsal* and *plantar scapheo-cuboid ligament.* The three cuneiform bones are connected to the scaphoid by dorsal ligaments, and by flat bands, as also by very strong plantar ligaments.

8. Tarso-Metatarsal Articulations. The three internal metatarsal bones are joined to the three cuneiform, and the fourth and fifth metatarsal to the cuboid. The tarso-metatarsal range of articulations is secured by strong transverse ligaments, dorsal and plantar, and by interosseous fibres.

9. The Metatarso-Phalangeal Articulations are arthrodial, and furnished with synovial membranes, protected by dorsal, plantar, and lateral ligaments. The phalanges of all the toes form ginglymoid joints, and are articulated to each other by synovial membranes and by lateral ligaments like those of the fingers.

II. THE MUSCLES, OR MYOLOGY OF THE HUMAN FRAME.

1. General Anatomy of the Muscles.

The muscles consist of aggregations of parallel, soft, contractile fibres, so connected with the bony framework and other parts of the system as to produce the various motions of the body. They constitute the portion of the animal usually known as the flesh, being composed of a peculiar reddish contractile tissue (tela muscularis), together with tendons, fat, blood-vessels, and nerves.

The muscles of the body have been divided into voluntary and involuntary, or those which are and those which are not under the control of the will. With this difference another is usually conjoined, viz. that the fibres of voluntary muscle are solid organs, exhibiting transverse and very close parallel lines, while the involuntary muscular fibre is hollow and consists of flattened bands, generally of a pale color, without transverse striæ, and bulged at frequent intervals by elongated corpuscles. While the former are parallel to each other, the latter are interwoven and arranged in many layers, so as to form a muscular skin, as in the intestinal canal, the bladder, &c. Their action is confined to the enlarging, contracting, or otherwise affecting the shape and size of certain cavities, and is dependent upon the influence of the sympathetic nerves. Still the division above referred to is not altogether correct, since the heart is composed of transverse fibres, while the muscular coat of the œsophagus often displays the striæ as far down as the stomach. The further consideration of the involuntary muscles will be more appropriate under the subject of Splanchnology; that of the voluntary will now occupy our attention.

The muscles of voluntary motion, then, or the flesh proper, are usually of a deep red color; they are mostly attached to the bones by means of tendons, and thus put them in motion. All, with few exceptions, have their

antagonists, or muscles whose action is in a directly contrary direction; the equilibrium being maintained by the influence of the nerves, the brain, and the spinal marrow.

Considering a muscle in itself, we find that at the more fixed place of its attachment it is usually thinner than elsewhere; this portion is called the *head* or *origin;* the middle and thicker part is the *belly;* while the opposite attachment is the *tail* or *insertion.* These extremities are usually tendinous, either entirely or partly. Their forms vary with the motion to be effected. *Radiated muscles* are those in which the fibres converge to a common point from a wide base, as in the diaphragm. *Sphincter muscles* are circular or annular, inclosing some cavity to be shut by their contraction, as in the eyelids, the mouth, and the anus. *Broad muscles* are thin and wide-spread, surrounding large cavities, as in some of the abdominal muscles. They usually arise by slips or points from neighboring muscles, and are inserted by a broad skin-like tendon. In *longitudinal muscles* the fibres run parallel to each other, and are either simple or compound. They are simple when they arise by a single head and are inserted into one point, and compound when there is a plurality of either heads or insertions, or of both. Some arise by numerous digitations or dentations, with one belly; others have several bellies. When there is a long tendon in the centre, to which the fibres from opposite sides converge obliquely, those on the same side being nearly parallel, the muscle is said to be penniform (*musculi pennati*); *semi-pennati*, when the fibres are on one side only.

Muscles, in respect to their antagonism, bear different names, according to the precise nature of the motions effected by them. Thus we have flexors and extensors, sphincters, elevators and depressors, protractors and retractors, &c. Their nomenclature also varies with their position, direction, shape, size, combination, origin, attachment, &c.

Muscles are assisted in their operation by tendons, usually placed at the insertion, but sometimes at both origin and insertion. They may exist at either end or at both, and again may not occur at all. Tendons may present themselves under two shapes: one like a cord, varying from cylindrical to paraboloid; the other is spread out into a membrane, and resembles an aponeurosis. They are readily recognisable by their white and shining appearance, possessing no elasticity; they are lacerated sooner than they can be stretched. They are composed of desmoid tissue, the fibres of which are united by a compact cellular substance in small quantities. The fibres are longitudinal, and may readily be separated by maceration or slight boiling. In ordinary health no red blood penetrates the tendons; in inflammation, however, their capillaries may become so much enlarged as to admit red globules; no nerves have ever been traced into them. They are more soluble in boiling water than the ligaments. They have a great affinity for phosphate of lime, and hence they are frequently found hardened by the development of bony matter, especially where they run over long trochleæ. The patella is an illustration of this ossification of tendon, as also the sesamoid bones found under various circumstances. Tendons are frequently confined to a motion in one direction by passing through sheaths,

or through loops, or else by the intervention of pulleys (*trochleæ*), in or over which they glide.

For the sake of facilitating the play of tendons, and to prevent friction, they are surrounded by loose cellular membranes (*vaginæ tendinum mucosæ*), which permit them to glide freely one on the other; in other places they glide over synovial sacs of a similar character (*bursæ mucosæ*), especially about the joints

2. Anatomy of the Fasciæ.

The muscles are intimately connected with certain membranous expansions (*fasciæ*) found in various regions of the body, and forming coverings to particular parts. These expansions are composed either of cellular tissue more or less condensed, or of fibrous tissue; the former are called *cellular fasciæ*, the latter the *aponeuroses* or *aponeurotic fasciæ*. They include and embrace not only single muscles but entire systems, maintaining them securely in their place and relative position. The most extensively distributed cellular fascia is that layer of cellular membrane immediately adjacent to the subcutaneous cellular tissue all over the body, and in most cases so intimately connected with it as to be inseparable. This is usually known as the *superficial fascia*. Although this is universal, there are nevertheless certain regions where it is of more importance than in others, as in the neck and abdomen; here it constitutes a distinct membraniform expansion. The cervical fasciæ bind down the muscles, and support the vessels and glands in this region; at the lower part of the neck they serve to protect the trachea and the upper part of the thorax from the pressure of the atmosphere during respiration.

Pl. 129, *fig.* 1, cervical fascia, the platysma myoides supposed to be removed: [1], superficial layer; [2], temporal aponeurosis; [3], portion over the parotid gland; [4], clavicular portion; [5]. continuation over the pectoralis major; [6], external jugular vein showing through the superficial layer.

Pl. 129, *fig.* 2 [1], middle layer of the cervical fascia; [2], cut edge of the superficial layer; [3], continuation of the middle layer beneath the sterno-cleido-mastoid muscle; [4], sheath for the cervical vessels; [5], section of the sterno-cleido-mastoid; [6], portion of the fascia attached to the lower jaw, separating the parotid gland, [7], from the submaxillary, [8].

Pl. 129, *fig.* 3, deep-seated layer: [1], section of the superficial layer; [2], do. of the sterno-cleido-mastoid; [3], middle layer; [4], deep-seated layer extending into the thoracic cavity, and passing above along the lower edge of the thyroid gland, [5].

Pl. 129, *fig.* 4 [1], layer descending anterior to the vertebral column; [2], scalenus anticus forming a swelling beneath it; [3], clavicle removed; [4], section of sterno-cleido-mastoid.

The eye is protected in a measure by the *ocular fascia*, which, although not very thick or strong, is tough, flocculent, and difficult to remove. It covers the recti muscles as far back as their origin, and is continued ante-

riorly over their tendons, but of a finer and denser tissue, nearly to the circumference of the cornea, and beneath the conjunctiva. It is also prolonged as a thick sheath round the trochleator tendon as far as its pulley, to which it is connected, and around the obliquus inferius to its origin. This fascia seems to connect and retain all these muscles and tendons in their proper relative situations both to each other and to the eyeball; it has, however, a still further and more interesting relation, for it is continued beneath the four recti, forming for each a perfect sheath and a non-adherent envelope for the posterior part of the eyeball.

Pl. 129, *fig.* 6[1, 2], aponeurotic tissue of the eyelids; [3], continuation of the same between the recti muscles, constituting a sheath to each; [4], investment of the sclerotica; [5], optic nerve.

Fig. 5 represents the *axillary fasciæ.*

The *brachial aponeurosis* invests the arm down to the elbow, over which it is partially continued into the fascia of the arm; it is weak and imperfect over the deltoid muscle, but increases in strength and tension as it descends. Its fibres are mostly in the circular direction, but many are spiral and vertical; above it is continuous with the fascia covering the pectoral and deltoid muscles; below the former it receives an addition from the fascia of the axilla (*fig.* 5). About the middle of the arm it adheres to the lateral ridges of the humerus by two septa named *internal* and *external intermuscular ligaments.* The brachial aponeurosis serves to confine the several muscles without restraining their actions, compressing them so as to preserve the form and symmetry of the limb; it also protects the vessels and nerves.

Fig. 18, brachial fascia: [1], portion covering the deltoid muscle; [2], portion on the arm; [3], portion on the forearm; [4], semilunar fascia of the biceps brachialis; [5], palmar fascia; [6], palmaris brevis muscle.

Fig. 19[1], carpal ligament; [2], dorsal fascia.

Fig. 7, cross section of the right arm at about the lower third of the deltoid muscle, showing the intermuscular laminæ of the brachial fascia.

Fig. 8, cross section of the right forearm at about the middle, for the same purpose.

The *superficial abdominal fascia* consists of a tolerably compact surface of cellular tissue and tendinous fibres, weak above but increasing in density as it descends from the thorax over the abdominal muscles. From the abdomen it extends on either side over Poupart's ligament to the thigh, which it invests, and in the centre over the organs of generation. The superficial fascia supports and connects the fleshy and tendinous fasciculi of the abdominal muscles; it also possesses some power of resistance and a good deal of elasticity, which assists these muscles in the contraction of the parietes of the abdomen. In the lower part of the abdominal muscles is seen the abdominal ring (*annulus abdominalis*) placed external and superior to the pubes on each side. It transmits, in the male, the spermatic cord and the cremaster muscle, with its vessels and nerves; and in the female, the round ligament of the uterus. Its external opening pierces through the superficial abdominal fascia.

Pl. 129, *fig.* 11 [1], rectus abdominalis; [2], superficial abdominal fascia reflexed; [3], external, and [4], internal portion of the transverse fascia; [5], posterior or inner abdominal ring.

The crural ring (*annulus cruralis*) is the triangular opening through which the femoral vessels emerge from the abdominal cavity. This is of a triangular form; the base externally is the femoral vein, the apex internally is Gimbernaut's ligament; it is bounded anteriorally by Poupart's ligament, and by the superior fibres or corner of the falciform process of the fascia lata, and posteriorly by the pubes.

Pl. 129, *fig.* 12 [1], suspensory ligament of the penis; [2], crural ring; [3], Gimbernaut's ligament; [4], lamina cribrosa; [5], femoral vessels.

Fig. 13 [1], sheath of the femoral vessels; [2], falciform process of the fascia lata.

The iliac fascia arises from the inner border of the entire crest of the ilium, and from Poupart's ligament external to the iliac artery. It is attached to the psoas and the iliacus muscles.

The superficial perinæal fascia occurs beneath the integument, and anterior to as well as on each side of the anus; it covers the muscles in the perinæum. The middle perinæal fascia, also called triangular ligament of the urethra, or septum perinæi, separates the anterior perinæum from the pelvis.

The pelvic fascia lines the cavity of the lesser or true pelvis.

Pl. 129, *fig.* 14 [1], fascia of the posterior face of the obliquus externus abdominis; [2], part connected with Poupart's ligament; [3], iliac fascia; [4], Cowper's ligament; [5], femoral vessels.

Fig. 15 [1, 2], superficial perinæal fascia.

Fig. 16 [1], cut edge of the superficial perinæal fascia; [2], deep-seated perinæal fascia; [3], opening for the passage of the vessels of the penis; [4], section of the urethra.

Fig. 17 [1], crural ring; [2], Gimbernaut's ligament; [3], Cowper's ligament; [4], iliac fascia helping to form the crural ring; [5], rectum; [6] urinary bladder laid back; [7], superficial perinæal fascia; [8], opening for the perinæal vessels; [9], obturator foramen; [10], anterior ligament of the bladder.

The *fascia lata* is united to the spine of the ilium, to the whole length of Poupart's ligament, as also to the linea innominata and spine of the pubes; it may be divided into three portions: the internal or pubic or pectineal, the external or iliac, and the middle or cribriform. It extends downwards over the thigh. The fascia of the leg is derived partly from the fascia lata of the thigh; it also receives additional fibres from the tendons around the knee-joint. Near the ankle it increases in strength from its connexion with the malleoli and three annular ligaments. From the anterior annular ligament a thin fascia is continued over the back of the foot; that covering the sole of the foot, or plantar fascia, is remarkably strong. Anteriorly it divides into three parts lying on different planes, and serving to separate the plantar muscles into three orders, the internal, middle, and external.

Pl. 129, *fig.* 20, fascia of the leg: [1], fascia covering the glutæus maxi-

mus; [2], femoral fascia; [3], investment of the tensor vaginæ femoris muscle; [4], fascia of the leg; [5], dorsal fascia of the foot.

Pl. 129, *fig.* 21, cross ligament of the foot.

Fig. 22, plantar aponeurosis.

Fig. 9, cross section of the right thigh, about the middle, to show the arrangement of the fascia.

Fig. 10, cross section of the leg.

3. Special Anatomy of the Muscles.

A. Muscles of the Head.

We may divide the muscles of the head into those of the cranium and those of the face. The proper muscles of the cranium are the occipito-frontalis and the three common muscles of the ear. The superficial muscles of the face are thirty-three in number, arranged in sixteen pairs and one azygos. They belong as follows:

Three pairs belong to the palpebral; viz. orbicularis palpebrarum, tensor tarsi, and corrugator supercilii.

Four pairs belong to the nose; viz. pyramidalis nasi, levator labii superioris alæque nasi, compressor and depressor naris.

Three pairs belong to the upper lip; viz. levator labii superioris, levator anguli oris, and depressor labii superioris.

Three pairs belong to the lower lip; viz. depressor anguli oris, depressor labii inferioris, and levator labii inferioris.

Three pairs to the mouth; viz. zygomaticus major, minor, and buccinator; also one azygos, the orbicularis oris.

The deep muscles of the face which are connected with the lower maxilla and are concerned in mastication, are the masseter, temporal, internal, and external pterygoid of each side.

We shall now proceed, in as brief terms as possible, to describe the attachments and functions of the most important of these muscles.

Occipito-frontalis. This is a single muscle, consisting of two symmetrical parts, coming from the back of the head and inserted into the front of it. It is placed immediately under the scalp, and has four bellies of muscular fibres, connected by a thick tendon. It arises from the superior semicircular ridges of the occipital bone, and is inserted into the superior margin of the orbicularis oculi, and of the corrugator supercilii; also into the os frontis and the roof of the nasal bones. Its object is to pull the skin backwards and forwards, throwing that of the forehead into horizontal wrinkles; it elevates the eyebrows.

The common muscles of the ear are: 1. *Superior auris*, or *attollens aurem*, arising from the cranial aponeurosis, and inserted into the upper and anterior part of the cartilage of the ear; its use is to raise the cartilage, and to stretch the epicranial fascia. 2. *Anterior auris*, or *attrihens aurem;* this arises from the posterior part of the zygomatic process, and from the cranial aponeurosis, and is inserted into the anterior part of the helix. Use: tc

draw the external ear forwards and upwards. 3. *Posterior auris*, or *retrahens aurem*, arises from the mastoid process above the sterno-mastoid muscle, and is inserted into the back part of the concha. Use: to enlarge the meatus of the ear, and to direct it backwards.

Orbicularis, or *sphincter palpebrarum*. This is a broad circular muscle, lying immediately under the skin of the eyelids. The first point of this muscle is principally the ligamentum palpebrale internum, and the internal canthus of the orbit; elsewhere it is but loosely attached to the subjacent parts.

Tensor tarsi. This arises from the posterior edge of the os unguis, passes forwards, and is inserted into the lachrymal ducts. Use: to draw the puncta and eyelids in close contact with the eye, and to press the former towards the nose; this muscle is sometimes called Horner's muscle, from its discoverer.

Corrugator supercilii arises from the internal angular process of the os frontis, and is inserted into the middle of the eyebrow, mixing with the orbicularis and occipito-frontalis muscles. Use: to depress and approximate the eyebrows, throwing the skin into vertical wrinkles, as in frowning.

Pyramidalis nasi arises from the occipito-frontalis, and is inserted into the compressor nasi muscle. Use: to raise the skin covering the ossa nasi.

Compressor nasi is a thin and triangular muscle, placed on the side of the nose, between the skin and the cartilage; it arises from the inner side of the canine fossa, in the superior maxilla, and is inserted by a thin aponeurosis into the dorsum of the nose, joining some fibres from the opposite side; its use is to press the ala towards the septum, or to draw it from it, so as alternately to enlarge or diminish the anterior nares.

Levator labii superioris alæque nasi is a long, thin, triangular muscle, placed on the side of the nose, between the orbit and the upper lip; it arises from two ridges: first, from the upper extremity of the nasal process of the superior maxilla; second, from the edge of the orbit above the infra-orbital hole; it is inserted into the ala nasi, and into the upper lip and orbicularis oris; its use is indicated by the name.

Zygomaticus minor is very small, and sometimes wanting; it arises from the upper part of the malar bone, and is inserted into the upper lip, near the commissure. Use: to draw the angle of the mouth upwards and outwards, as in smiling.

Levator anguli oris (musculus caninus) is situated about the middle of the face; it arises from the canine fossa in the superior maxillary bone, immediately below the infra-orbital foramen, and above the alveolus of the first molar tooth, and is inserted into the commissure of the lips, and into the orbicularis oris.

Depressor labii superioris alæque nasi. This arises from the myrtiform fossa in front of the alveoli of the canine and incisor teeth of the upper maxilla, and is inserted into the integuments of the upper lip, and into the fibro-cartilage of the septum and ala nasi. Use: to press the lips against the anterior teeth, and to depress the septum and ala nasi.

Depressor anguli vel triangularis oris is a flat and triangular muscle,

situated at the lower part of the face; it arises from the external oblique line on the outer side of the lower jaw, which extends from the anterior edge of the masseter muscle to the mental foramen; its insertion is into the commissure of the lips; its name denotes its use.

Depressor labii inferioris vel quadratus menti is broad and somewhat square; arises from the side and front of the lower maxilla, and is inserted into half the lower lip, and into the orbicularis oris; it conceals the following muscle.

Levator labii inferioris vel menti arises from the alveoli of the lower incisors, by the side of the symphysis; it is inserted into the integument of the chin; its use is to elevate the chin and lower lip.

Orbicularis vel sphincter oris surrounds the opening of the mouth, and consists of two fleshy fasciculi, one for each lip, whose fibres decussate at the commissures, and intermix with all the dilating muscles inserted there; its use is to approximate the lips, and regulate their motion in the acts of speaking and breathing. This muscle has no bony attachment.

Buccinator. This is broad, thin, and somewhat square; situated between the two alveolar arches, it forms the inner side of the cheek and the lateral boundary of the mouth, lying close to the mucous membrane of the latter. It arises from the two posterior alveoli of the superior maxilla, from the external surface of the posterior alveoli of the lower maxilla, and from a strong aponeurosis (the pterygo-, or inter-maxillary ligament). It is inserted into the commissure of the lips; its uses are to press the cheek against the teeth, and to assist in other operations of mastication and articulation.

The first of the deep-seated muscles of the face is the *masseter.* This strong muscle covers the ramus and angle of the jaw, and consists of two parts, one anterior, the other posterior. The anterior arises from the superior maxilla where it joins the malar bone, and from the inferior edge of the latter, and is inserted into the outer surface of the angle of the lower maxilla. The posterior portion arises from the edge of the malar bone, and is inserted into the external side of the angle and ramus of the jaw. When both portions of both muscles act together, they elevate the lower jaw; if the anterior portions only of opposite sides act, they carry the face forwards and upwards; if the posterior alone act, they carry it backwards and upwards; if the superficial layer of one side act alone, it can rotate the chin to the opposite side; and if the deep layer only act, it can rotate the chin to its own side.

The *temporalis* is concealed by the temporal aponeurosis, the zygoma, and the masseter; it fills the temporal fossa, and arises from all sides of the cranium beneath the semicircular ridge on the parietal bone, and from all the temporal fossa and fascia; it is inserted by a strong tendon into the coronoid process of the inferior maxilla; it nearly surrounds that process, except on its outer side, and is continued along its fore part as far as the last molar tooth; its principal use is to raise the lower jaw, but it may assist to move the jaw forwards, backwards, and laterally.

Pterygoideus internus is situated on the inner side of the ramus of the jaw: it arises from the inner side of the external pterygoid plate and ptery-

goid process of the palate bone; it fills the greater part of the pterygoid fossa, and is inserted into the inner side of the angle of the jaw. Its use is to draw forward and elevate the jaw, and to rotate it.

Pterygoideus externus arises from the outer side of the external pterygoid plate, from the crest on the root of the great wing of the sphenoid, and from the back part of the tuberosity of the superior maxilla; it is inserted into the anterior and internal part of the neck of the lower jaw, into the inter-articular cartilage, and into the inferior synovial membrane. Its use is to draw forward the jaw with the inter-articular cartilages: when both muscles act alternately, they become the principal agents in grinding the food.

Pl. 127, *fig.* 1, superficial muscles of the head from the left side: [1], epicranial aponeurosis; [2,3], occipito-frontalis, anterior portion; [4], posterior portion, the two connected by the epicranial aponeurosis; [5], attollens aurem; [6], retrahens aurem; [7], attrahens aurem; [8], orbicularis palpebrarum; [9], compressor naris; [10], levator labii superioris alæque nasi; [11], levator labii superioris; [12], zygomaticus minor; [13], zygomaticus major; [14], levator anguli oris; [15], depressor anguli oris; [16], depressor labii inferioris; [17], levator menti; [18], orbicularis oris; [19], buccinator; [20], masseter.

Fig. 2, deep-seated muscles of the head from the left side: [1], temporal muscle; [2], corrugator supercilii; [3], superior oblique muscle of the eye; [4], levator palpebræ; [5], compressor naris; [6], depressor naris; [7], orbicularis; [8], levator anguli oris; [9], depressor labii inferioris; [10], buccinator.

Pl. 124, *fig.* 15 [1], epicranial aponeurosis; [2], occipito-frontalis; [3], compressor naris; [4], levator labii superioris alæque nasi; [5], levator proprius labii superioris; [6], orbicularis; [7], depressor anguli oris; [8], depressor labii superioris; [9], transversus menti (of rare occurrence); [10], attollens aurem; [11], attrahens aurem; [12], orbicularis palpebrarum; [13], zygomaticus major; [14], zygomaticus minor.

Fig. 16 [1], occipital portion of occipito-frontalis; [2], retrahens aurem.

Fig. 17 [1], occipital portion of occipito-frontalis.

Pl. 125, *fig.* 19 [1], temporalis; [2], levator palpebræ superioris; [3], zygomaticus; [4], orbicularis; [5], levator anguli oris; [6], masseter.

Fig. 20 [1], temporal muscle.

Pl. 126, *fig.* 20 [1], orbicularis; [2], buccinator; [3], levator menti.

B. Muscles of the Neck.

The neck is that contracted portion of the trunk between the head and chest, the cervical vertebræ forming its skeleton or support. Its anatomy is very intricate, containing numerous muscles, nerves, and vessels, besides the pharynx, œsophagus, larynx, and trachea. The muscles on the back of the neck will be considered with those of the back of the trunk. We shall confine ourselves to those of the anterior and sides.

The muscles of the anterior part of the neck are very numerous, and are concerned in the performance of various functions. Some act as muscles of locomotion, others are engaged in deglutition, in respiration, and in the exercise of voice and speech. They are symmetrical or similar on each

side of the median line, and are twenty-one pairs in number, arranged in three layers, a superficial, middle, and deep. The superficial consists of two pairs, the platysma myoides and sterno-cleido-mastoid. The middle may be divided into two orders, the inferior and superior. The inferior are three: the sterno-hyoid, sterno-thyroid, and omo-hyoid; the superior are nine: digastric, mylo-hyoid, genio-hyoid, three styloid muscles, and the hyo-glossus, genio-hyo-glossus, and lingualis muscles. The deep layer consists of seven pairs: longus colli, rectus capitis, anticus major and minor, rectus lateralis, and three scaleni. This arrangement excludes the muscles of the palate, pharynx, and larynx.

The *platysma myoides*, or latissimus colli, is a thin, pale, cutaneous muscle, weak and indistinct in many subjects; it is situated on the fore part and side of the neck, extending from the chest and shoulder to the face; it arises by many fine fibres from the cellular membrane covering the upper part of the deltoid and pectoral muscles. It is inserted, first, into the skin and cellular tissue of the chin; second, into the fascia along the sides of the lower jaw; third, into the fascia which covers the parotid, and which adheres to the meatus auditorius. Its use is to depress the angle of the lip and the lower jaw, as also to compress and support the several muscles, glands, and vessels in the region of the neck.

The *sterno-cleido-mastoideus* is situated at the anterior and lateral part of the neck: it arises by a strong flat tendon from the upper and anterior part of the first bone of the sternum, also from the upper edge of the clavicle, and is inserted into the upper part of the mastoid process, and into the superior transverse ridge of the occipital bone. The sternal portion can rotate the head so as to turn the face towards the opposite side; the clavicular can bend the head and neck, so as to approximate the ear and shoulder. Both portions acting together on each side will move the head downwards and forwards.

The *sterno-hyoideus*, a long, flat, and thin muscle, arises within the thorax from the posterior surface of the first bone of the sternum and sternal end of the clavicle, and is inserted into the lower border of the body of the os hyoides, internal to the omo-hyoid. Use: to depress the os hyoides, pharynx, and larynx.

The *sterno-thyroideus* is broader and shorter than the last: it arises from the posterior surface of the sternum and cartilage of the second rib, and is inserted into the oblique line on the ala of the thyroid cartilage. Its use is to depress the larynx.

The *omo-hyoideus* is a long and slender muscle, situated obliquely along the inferior, lateral, and fore part of the neck. It arises from the superior costa of the scapula behind its semi-lunar notch, and sometimes from the acromial end of the clavicle, and is inserted into the lower border of the os hyoides. Its use, in conjunction with its fellow on the opposite side, is to draw the os hyoides, pharynx, and larynx, downwards and backwards.

The *digastricus*, placed at the lateral and anterior part of the neck, thick and fleshy at each extremity, round and tendinous in the centre, arises from a groove in the temporal bone internal to the mastoid process, and is in-

serted into a rough depression on the inner side of the base of the jaw close to the symphysis. Its median tendinous portion passes through the stylo-hyoid muscle, and is connected with the corner of the hyoid bone by a dense fascia, and sometimes by a tendinous ring like a pulley. Its use is to depress the lower jaw, and when the mouth is closed to elevate the os hyoides, tongue, and larynx.

The *mylo-hyoideus* is a triangular muscle, arising from the myloid ridge on the inner surface of the sides of the maxilla, which line descends obliquely from the last molar tooth towards the chin: it is inserted into the base of the os hyoides. Use: to elevate the os hyoides and tongue, so as to press the latter against the palate.

The *genio-hyoideus*, short and round, arises by a small tendon on the inner side of the chin, above the digastric, and descending, is inserted into the base of the os hyoides. Its use is to draw the os hyoides upwards and forwards, to push the tongue against the incisor teeth, or to protrude it from the mouth.

The *hyo-glossus* is flat and thin, arising from the corner and part of the body of the os hyoides, and being inserted into the side of the tongue. Use: to render the dorsum of the tongue convex by depressing its side; it may also elevate the os hyoides and base of the tongue.

The *genio-hyo-glossus* is triangular or fan-shaped: it arises by a small tendon from an eminence inside the chin beneath the frænum linguæ: the insertion is into the mesial line of the tongue from the apex to the base, and into the body or lesser corner of the os hyoides. This muscle is of importance in mastication and deglutition, as also in the articulation of certain letters.

Lingualis is a fasciculus of fibres taking a longitudinal course on the inferior surface of the tongue from the base to the apex; its use is to shorten the tongue and bend the tip downwards and to one side.

Stylo-hyoideus arises from the outer side of the styloid process near its base, and is inserted into the cornu and body of the os hyoides. It co-operates with the digastric in raising and drawing back the os hyoides and tongue.

Stylo-glossus arises from the inner side of the styloid process near its point, and is inserted into the side of the tongue. It draws the tongue backwards and to one side, and raises the tip behind the upper incisors.

Stylo-pharyngeus arises from the back part of the root of the styloid process, and is inserted into the side of the pharynx, also into the corner of the os hyoides and thyroid cartilage. It elevates and dilates the pharynx so as to receive the food from the tongue.

Longus colli, the first of the deep layer of the muscles of the neck, extends from the third dorsal vertebra to the atlas: it arises from the sides of the bodies of the three superior dorsal and four inferior cervical vertebræ, from the intervertebral ligaments, also from the head of the first rib and from the anterior tubercles of the transverse processes of the last four cervical vertebræ. The fibres ascend obliquely, adhering to each bone in their course, and are inserted into the fore part of the first, second, and

third cervical vertebræ. Use: to bend the neck on one side, and rotate the atlas on the vertebra dentata; when both muscles act, they bend the neck directly forwards.

Rectus capitis anticus major, long and flat, thick above and below, arises by small tendons from the anterior tubercles of the transverse processes of the last four cervical vertebræ; they soon unite in a fleshy substance, which is inserted into the cuneiform process of the occipital bone. It serves to bend forwards the head and neck.

Rectus capitis anticus minor, short and narrow, arises from the transverse process of the atlas, and is inserted into the cuneiform process. It serves to bend the head forwards and to one side on the atlas.

Rectus capitis lateralis, very short, arises from the transverse process of the atlas, and is inserted into the semilunar ridge or jugular process of the occipital bone which extends from the condyle to the mastoid process. With the last muscle it serves to bend the head forwards or to incline it to one side.

Scalenus anticus, in part continuous with the rectus anticus major, arises from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; the fibres descending form a flat muscle, which is inserted tendinous into the upper surface of the first rib, near its cartilage. Its use is to bend the neck forwards and laterally, also to elevate and fix the rib, as in inspiration.

Scalenus medius, larger and longer than the last, arises from the posterior tubercles of the transverse processes of four or five inferior cervical vertebræ, and is inserted into the upper surface of the first rib, behind the subclavian artery. Its use is similar to that of the last.

Scalenus posticus arises from the posterior tubercles of two or three lower cervical vertebræ, and is inserted into the upper edge of the second rib, between the tubercle and angle. Use: to elevate the second rib; to bend the neck to one side and a little backwards.

Pl. 127, *fig.* 3[1], platysma myoides; [2], branch of the latter known as musculus risorius santorini; [3], sterno-cleido-mastoid; [4], trapezius.

Fig. 4[1, 2], the digastric muscle.

Pl. 124, *fig.* 15[16], platysma myoides.

Pl. 125, *fig.* 19[7], sterno-cleido-mastoid.

C. Muscles of the Anterior and Lateral Parts of the Thorax.

The thorax is the middle division of the body, continuous with the neck above and the abdomen below; it presents an anterior or sternal, a posterior or dorsal, and two lateral aspects.

Pectoralis major, flat and triangular, arises from the sternal half of the clavicle, from the anterior surface of the sternum, from the cartilages of the third, fourth, fifth, and sixth true ribs, and from an aponeurosis common to it and to the external oblique muscle; its fibres are inserted by a flat tendon into the anterior edge of the bicipital groove, and by an aponeurosis into the fascia of the arm. A line of cellular membrane separates the clavicular from the sternal portion, these in some cases appearing as dis-

tinct muscles. It serves important purposes in moving the arm and in inspiration.

Pectoralis minor, flat and triangular, arises from the external surface and upper edge of the third, fourth, and fifth ribs, external to their cartilages, and is inserted into the inner and upper surface of the coracoid process of the scapula, near its anterior extremity, being here connected with the coraco-brachialis and short head of the biceps. Use: to draw the shoulder forwards, downwards, and upwards, also to assist the pectoralis major in elevating the ribs in inspiration.

Subclavius, small and round, arises by a flat tendon from the cartilage of the first rib, external to the rhomboid or costo-clavicular ligament; it is inserted into the external half of the inferior surface of the clavicle. Its use is to draw the clavicle and shoulder forwards and downwards; also to elevate the first rib in inspiration, if the shoulder and clavicle be raised and fixed.

Serratus magnus, thin and broad, placed between the scapula and the ribs, arises by eight or nine fleshy strips from the eight or nine superior ribs; the fibres ascending are inserted between the subscapular, rhomboid, and levator anguli muscles into the base of the scapula, but particularly into the superior and inferior angles. It depresses the scapula and draws it forwards, raising the acromion process and the shoulder joint by rotating the scapula on its axis; it also plays an important part in inspiration.

Intercostales are twenty-two in number on each side, eleven external and eleven internal. The external commence at the transverse processes of the dorsal vertebræ, arise from the inferior edge of each rib, and are inserted into the external lip of the superior edge of the rib beneath. The internal intercostals take an opposite direction and decussate the former; they commence at the sternum and are discontinued at the angles of the ribs. They arise from the inner lip of the lower edge of each cartilage and rib, and are inserted into the inner lip of the superior edge of the cartilage and rib beneath. Both laminæ co-operate to raise the ribs, the first rib being fixed by the scaleni.

Levatores costarum arise from the extremity of each dorsal transverse process, and are inserted into the upper edge of the rib beneath, between its tubercle and angle. They serve to elevate the ribs.

Triangularis sterni, or sterno-costalis, arises from the posterior surface and edge of the lower part of the sternum, and from the xiphoid cartilage, and is inserted into the cartilages of the fourth, fifth, and sixth ribs. Use: to depress and draw back the cartilages of the ribs, so as to assist in expiration.

Pl. 127, *fig.* 9 [1], pectoralis major; [2], pectoralis minor; [3], subclavius; [4], serratus magnus; [5], intercostals.

Pl. 124, *fig.* 15 [18], pectoralis major. *Fig.* 17 [7], serratus magnus.

Pl. 125, *fig.* 19 [8], subclavius; [9], pectoralis minor; [10], dentations of the serratus magnus.

Pl. 126, *fig.* 20 [15, 16], intercostals.

D. Muscles of the Back.

The muscles of the back are many of them indistinct, and vary considerably in different bodies. They are symmetrical on each side, and may be arranged in four successive layers, each nearly covering the other, between the integuments and the bones. The muscles of the first layer are two in number.

The *trapezius*, broad and triangular, with the base along the spine, the apex at the shoulder, arises from the internal third of the superior transverse ridge of the occipital bone, from the ligamentum nuchæ, and from the spinous processes of the last cervical and of all the dorsal vertebræ; it is inserted into the posterior border of the external third of the clavicle and of the acromion process of the scapula. Its use is to raise and draw backwards the shoulder.

The *latissimus dorsi* is triangular and very broad, covering the greater part of the lumbar and dorsal region; it arises from all the lumbar spines and supra-spinal ligaments, also from the pelvis and last three or four ribs; its insertion is into the concave surface and into the inner or posterior edge of the bicipital groove. Use: to depress the shoulder and arm, to draw the arm backwards and inwards, to rotate the humerus inwards, &c.

The second layer of muscles consists of the rhomboid, levator anguli scapulæ, serratus inferior and superior, and the splenii.

Rhomboideus is broad and thin, and is the most superficial of this layer; it is divided into a superior or minor portion, and an inferior or major; the former arises from the lower part of the ligamentum nuchæ, and from the two last cervical spinous processes, and is inserted into the base of the scapula, opposite to and above the spine; the major portion arises from the four or five superior dorsal spines, and is inserted into a thin tendinous arch, extending along the base of the scapula from its spine to its inferior angle. Use: to draw the shoulder backwards and upwards.

Levator anguli scapulæ is a long and flat muscle, placed at the upper and posterior part of the side of the neck; it arises from the posterior tubercles of the transverse processes of the four or five superior cervical vertebræ, and is inserted into the base of the scapula, between the spine and the superior angle; its use is to elevate the whole scapula, when it is assisted by the trapezius, or alone, to raise the superior angle.

Serratus posticus superior is placed on the superior posterior part of the thorax, arises from the ligamentum nuchæ and from two or three dorsal spines, and forms a thin fleshy belly ending in three fleshy strips, which are inserted into the upper borders of the second, third, and fourth ribs, external to their angles. Use: to expand the thorax by elevating the ribs, and drawing them outwards.

Serratus posticus inferior, at the lower part of the dorsal and upper part of the lumbar regions, arises by a tendinous expansion, connected through the lumbar fascia to the two last dorsal and two upper lumbar spines. Its three or four fasciculi are inserted into the lower edges of the four inferior

ribs, anterior to their angles; its use is to assist the abdominal muscles in expiration, and the diaphragm in inspiration.

Splenius is long, fleshy, and tendinous, lying beneath the trapezius; it is divided about its centre into two portions: the inferior or splenius colli, and the superior or splenius capitis. The former arises from the spines of the third, fourth, fifth, and sixth dorsal, and is inserted into the transverse processes of the three or four superior cervical vertebræ. The latter arises from the spinous processes of the two superior and dorsal, and three inferior cervical vertebræ, and is inserted into the back part of the mastoid process. The use of the splenius muscles is to bend back the head; and where one only acts, to turn the head to that side.

The next layer of muscles consists of the sacro-lumbalis, longissimus dorsi, spinalis dorsi, cervicalis descendens, transversalis colli, trachelo-mastoideus, and complexus.

Sacro-lumbalis, *longissimus dorsi*, and *spinalis dorsi* are so closely connected inferiorly as to appear but one mass; they fill the hollow between the angles of the ribs and the spinous processes; the first is external, the second in the middle, and the third internal. They serve to strengthen the spine, and to assist in respiration.

Cervicalis descendens or *ascendens* arises internal to the sacro-lumbalis, by four or five tendons, from as many of the superior ribs, between their tubercles and angles; it is inserted into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ. Use: to extend the neck, and incline or turn it to one side; it may also assist in respiration.

Transversalis colli arises internal to the longissimus dorsi, by small slips, from the transverse processes of five or six superior dorsal vertebræ; it is inserted by small tendons into the transverse processes of four or five inferior cervical vertebræ; its use is nearly similar to that of the last described muscle.

Trachelo-mastoideus, like a continuation of the longissimus dorsi, lies internal to the last, and external to the next. It arises from the transverse processes of three or four superior dorsal vertebræ, and from as many inferior cervical; ascending, it is inserted into the inner and back part of the mastoid process, beneath the insertion of the splenius; it assists in extending the neck, in bringing the head backwards, and inclining and rotating it to one side.

Complexus is thick and strong, and arises from the transverse and oblique processes of three or four inferior cervical, and five or six superior dorsal vertebræ, internal to the transversalis and trachelo-mastoideus; it is inserted close to its fellow into the occipital bone, between the two transverse ridges. Use: to draw back the head; to fix and support it on the spine; also, to rotate it as antagonistic to the splenius.

Spinalis, or *semi-spinalis colli*, is one of the largest muscles in this region. It arises from the extremity of the transverse processes of five or six superior dorsal vertebræ, and is inserted into the spinous processes of the second, third, fourth, and fifth cervical vertebræ; its use is to extend the neck, and incline it to its own side.

Semi-spinalis dorsi is similar to the last mentioned muscle in form, attachment, and function.

Multifidus spinæ is close to the vertebræ, between the spinous and the transverse processes. It consists of a series of small tendinous and fleshy fasciculi; the first arises from the spine of the dentatus, and is inserted into the transverse process of the third; the last arises from the spine of the last lumber vertebra, and is inserted into the false transverse process of the sacrum. It supports the spinal column, strengthens it, and inclines it to one side.

Interspinales are short muscles, consisting of longitudinal fibres, whose attachment is indicated by the name; they support and extend the spine.

Intertransversales consist of longitudinal fibres, attached and situated as implied by the name. Use: to support the spine on either side, and to bend it laterally.

Rectus capitis posticus major is a triangular muscle, arising from the spinous process of the second vertebra; it is inserted into the inferior transverse ridge of the occipital bone. Use: to extend the head or draw it backwards, also to rotate it and the atlas on the second cervical vertebra.

Rectus capitis posticus minor, also triangular, arises from the posterior part of the atlas, and is inserted into the occipital bone, behind the foramen magnum. Use: to assist the preceding muscle in drawing back the head and steadying it on the spine.

Obliquus capitis inferior is the strongest of these small muscles; it arises inferiorly and externally to the posterior rectus, from the spinous process of the second vertebra, and is inserted into the extremity of the transverse of the atlas. Use: to rotate the head and atlas on the second vertebra.

Obliquus capitis superior arises from the upper part of the transverse process of the atlas, and is inserted into the occipital bone, between its transverse ridges, and just behind the mastoid processes. Use: to bend the head to one side, and to draw it a little forwards.

Pl. 124, *fig.* 16[4], trapezius; [16], latissimus dorsi.

Pl. 125, *fig.* 20[2], splenius; [3], levator scapulæ; [4], rhomboideus; [6], serratus posticus superior; [9], serratus posticus inferior; [10], quadratus lumborum.

Pl. 126, *fig.* 21[1], rectus capitis posticus minor; [2], rectus capitis posticus major; [3], obliquus capitis superior; [4], obliquus capitis inferior; [5], biventer cervicis and complexis; [6], semispinalis colli; [7], scalenus posticus; [8], trachelo-mastoid; [9], transversalis colli; [10], cervicalis descendens or ascendens; [18], multifidus spinæ; [19], semispinalis dorsi; [20], spinalis dorsi; [21, 22], levatores costarum; [23], intertransversalis; [24], posterior attachment of the transversalis abdominis; [25], 20[19], *pl.* 127, *fig.* 11[12], quadratus lumborum.

Pl. 128, *fig.* 1[1], serratus posticus superior; [2], serratus posticus inferior; [3], dorsal aponeurosis; [4], splenius capitis; [5, 6], sacro-spinalis; [7], cervicalis ascendens; [8], trachelo-mastoid; [9], semi-spinalis dorsi et colli; [10], complexus; [11], spinalis dorsi et colli.

Fig. 2[1], splenius capitis; [2], splenius colli; [3, 6], complexus; [4], trachelo mastoid.

Fig. 3 [1], complexus; [2], trachelo-mastoid; [3], minor, [4], major rectus capitis posticus; [5], obliquus capitis, inferior and superior.

E. Muscles of the Abdomen and Pelvis.

The abdominal and pelvic muscles proper may be divided into the *superficial*, consisting of the obliquus externus and internus, transversalis, rectus, and pyramidalis of each side, and the *deep-seated*, viz. the quadratus lumborum, psoas parvus and magnus, and iliacus internus of each side, and the diaphragm.

The *obliquus externus*, or *descendens*, broad, thin, and somewhat square, extends over the anterior and lateral part of the abdomen. It arises by eight or nine triangular fleshy slips from the lower edges and external surface of the eight or nine inferior ribs at a little distance from their cartilages; this serrated origin is in the form of a long curved line, the concavity upwards and backwards. The insertion is into the xiphoid cartilage, linea alba, pubes, Poupart's ligament (formed by a thickening and reflection or folding back of the lower fibres of this tendon), and into the anterior superior spinous process of the ilium, also into the outer edge of the two anterior thirds of the crest of the ilium. Use: to depress and abduct the ribs, and to compress the abdominal viscera so as to assist in expiration and in the evacuation of the urine and fæces. The *linea alba* is a dense ligamentous cord extending from the ensiform cartilage to the upper part of the symphysis pubis, and is formed by the intimate union and crossing of the tendinous fibres of the two oblique and transverse muscles of opposite sides. The *lineæ semi-lunares* extend from the tuberosity of the pubes on each side, about four inches from the linea alba, towards the cartilages of the eighth and ninth ribs. They appear white and somewhat depressed, and are formed by the tendons of the internal oblique, dividing at the edge of each rectus into two layers, to inclose the muscle in a sort of sheath. The *lineæ transversæ* are three or four on each side; they cross the rectus muscle from the linea alba to the lineæ semi-lunares; they are tendinous intersections of that muscle, particularly of its anterior part, which adhere so intimately to its sheath as to give the latter this indented appearance. *Poupart's ligament*, as already remarked, is the inferior edge of the tendon of the external oblique, thickened and reflected. Considered as a distinct ligament, it may be said to arise from the anterior superior spinous process of the ilium, and passing forwards and inwards, to be inserted into the pubes by two attachments; one anteriorly into the tuberosity or spine, the other principally into the innominata of the pubes. This second insertion is sometimes known as Gimbernaut's ligament.

Obliquus internus or *ascendens* is also situated at the anterior and lateral part of the abdomen, broader before than behind. It arises from the fascia lumborum, from all the crest of the ilium, and from the two external thirds of the grooved or abdominal surface of Poupart's ligament, and is inserted into the cartilages of the four inferior ribs, the xiphoid cartilage, the cartilage of the seventh and eighth ribs, and the whole length of the linea alba: its tendon conjoined with that of the transversalis is inserted into the

symphysis and upper edge of the pubes, as also into the linea innominata. The use of this muscle is to assist the external oblique in expiration by depressing the ribs; also to bend the trunk forwards or to one side.

The cremaster or *suspensorius testis*, hardly a distinct muscle, and only rudimental in the female, consists of a fasciculus of pale fleshy fibres which arise from the internal surface of the external third of Poupart's ligament, and from the lower edge of the obliquus internus; the fibres pass downwards and forwards around the spermatic cord, and are inserted into the tunica vaginalis; a few fibres are lost in the scrotum. Use: to support, compress, and raise the testicle and its vessels.

Transversalis, a somewhat square muscle, arises from the fascia lumborum and the posterior part of the crest of the ilium, and from the iliac third of Poupart's ligament; also from the two last ribs, and by fleshy slips from the inner side of the succeeding five. All the fibres end in a flat tendon, which near the lineæ semi-lunares joins the posterior lamina of the internal oblique, and is inserted along with it into the whole length of the linea alba, into the upper edge of the pubes, and also into the linea innominata. Its use is to compress the abdominal viscera in the circular direction, and to assist in expiration.

The rectus abdominis is a long and flat muscle situated in the anterior part of the abdomen. It arises by a flat tendon, which is sometimes double, from the upper and anterior part of the pubes, between the spine and symphysis; it ascends parallel with its fellow, and is inserted into the anterior part of the thorax by three fasciculi. Of these, the internal is fixed to the cartilage of the seventh rib and costo-xiphoid ligament; the middle to the cartilage of the sixth rib; and the external to the cartilage of the fifth rib. It use is to bend the chest towards the pelvis, and to compress the abdomen.

The *pyramidalis*, sometimes wanting, arises from the symphysis pubis, and from the upper edge of the bone external to it, and is inserted into the linea alba, midway between the umbilicus and pubes. Use: to assist the rectus and make tense the linea alba.

The diaphragm, the first of the deep muscles of the abdomen, is one of the most important in the body, second only to the heart. It is the principal agent in respiration, and is in a measure only under the influence of volition. It is usually divided into two portions, one superior, large, and broad transversely (the true or costal diaphragm); the other is inferior and posterior, small, thick, and narrow (the appendix, crura, or vertebral diaphragm). These two portions, although separate at their osseous attachments, are yet blended together in the common central tendon and present a fan-shaped expansion, bent at their junction, the broad superior portion being nearly horizontal, while the posterior inferior is vertical and joined to the former at nearly a right angle. The superior arises. The central or cordiform tendon of the diaphragm is of considerable extent, and is entirely surrounded by fleshy fibres. Below this tendon are the two crura or appendices, nearly parallel to the spine. There are three large openings in the diaphragm: one for the aorta (*hiatus aorticus*), of a semi-

lunar form, and in the median line; one for the inferior vena cava (*foramen venæ cavæ* or *quadrilaterum*), nearly square, and to the right side; and one for the œsophagus (*hiatus œsophageus*), elliptical, and to the left side.

The quadratus lumborum is a thick, flat, irregularly square muscle, situated in the lumbar region next the spine, forming part of the posterior wall of the abdomen. It arises from the posterior fourth of the crest of the ilium and from the ilio-lumbar ligament; it is inserted into the extremity of the transverse processes of the four first lumbar vertebræ and of the last dorsal. Its use is to bend the spine to one side, to depress the last rib, and thus assist in expiration; both muscles acting together support the spine.

Psoas parvus, a long, thin, and narrow muscle, is situated behind the psoas magnus and arises from the lower edge of the side of the body of the last dorsal vertebra, also from the body of the first lumbar, and the intervertebral substance; it ends in a thin tendon which crosses the psoas magnus and is inserted into the ilio-pectineal eminence and adjacent part of the brim of the pelvis. Use: to assist in bending forwards the body or in raising the pelvis.

Psoas magnus extends along the sides of the lumbar vertebræ, the brim of the pelvis, and the anterior and inner part of the thigh, as a long, round, and fleshy muscle. It arises by two planes of fasciculi, the one anterior from the sides of the border of the two last dorsal and four first lumbar vertebræ; the other posterior, from the bases of the transverse processes. The fibres become attached to a tendon in common with those of the iliacus muscle, which passing around the hip joint becomes inserted into and around the lesser trochanter of the femur. Its use is to flex the thigh on the pelvis, or the pelvis on the thigh; in standing it supports the spine and prevents its bending backwards; it is especially concerned in walking.

The iliacus internus, a flat, radiated, or triangular muscle, arises from the transverse process of the last lumbar vertebra, ilio-lumbar ligament, base of the sacrum, inner margin of the crest of the ilium, the brim of the acetabulum, &c., and is inserted into the common tendon of the psoas magnus as already described. It assists the psoas in flexing and rotating the thigh.

We next proceed to the consideration of the perinæal muscles, the first of which is the *sphincter ani externus*, a flat, thin, oval muscle, open in the middle. It arises from a fibro-cellular substance extending from the os coccygis to the rectum (recto-coccygeal ligament), and encircling the anal orifice, is inserted into the raphe or prominent hard ridge of the perinæum and into the superficial fascia. It serves to close and raise the anus, also to draw the bulb of the urethra downwards and backwards, and to compress it.

The sphincter ani internus vel orbicularis is a thick fasciculus of muscular fibres, encircling the lower extremity of the rectum, with no attachment to the rectum behind, and only a slight one to the central point before, but is in close contact with the mucous membrane of the intestine.

Its use is to assist the former muscle in closing the extremity of the rectum in defecation.

Erector or *compressor penis*, a long and flat muscle, arises from the inner surface of the tuber ischii, and from the insertion of the great or inferior sacro-sciatic ligament: it is inserted into the fibrous membrane of the corpus cavernosum of the penis. Its use is to draw down and facilitate the erection of the penis.

Accelerator urinæ, or *ejaculator seminis*, extends from the front of the rectum to the back part of the scrotum, and is attached to its fellow along the mesial line. Use: to expel the last drops of semen or urine.

Transversalis perinæi is a thin and weak muscle, sometimes wanting: it arises from the inside of the tuberosity of the ischium above the erector penis muscle, and is inserted into the central portion of the perinæum behind the accelerator urinæ. It supports and raises the anus, assisting also in defecation.

Levator ani is a flat, thin, and broad muscle, placed at the inferior and lateral part of the pelvis. It arises by three origins, the first from the posterior part of the symphysis pubis, the second from the obturator fascia and the ilium, the third from the inner surface of the ischium: it is inserted into the central point of the perinæum, and into the fore part of the rectum, into the sides of the rectum, and into the back part of the rectum, as also into the two last bones of the coccyx. Its use is to raise and draw forward the rectum, as also to close it; it also assists powerfully in the evacuation of fæces, urine, and semen.

The coccygeus is a small triangular muscle posterior to the levator ani: it arises from the inner surface of the spine of the ischium, and is inserted into the extremity of the sacrum and side of the coccyx. It supports and raises the coccyx in defecation, and assists in closing the inferior and posterior part of the pelvis.

Pl. 124, *fig.* 15 [27], obliquus internus; [28], rectus abdominis. *Fig.* 17 [8], obliquus externus.

Pl. 125, *fig.* 19 [11], linea alba; [12], rectus abdominis crossed by the lineæ transversales; [13], transversus abdominis.

Pl. 126, *fig.* 20 [18], transversus abdominis.

Pl. 127, *fig.* 9 [6], obliquus externus; [7], femoral ring; [8], obliquus internus; [10], section of the aponeurosis of the obliquus externus; [11], linea alba. *Fig.* 10 [1, 2, 3], obliquus internus; [4, 5, 6], transversus abdominis; [7], pyramidalis; [8], rectus abdominis; [9], linea alba. *Fig.* 11 [1], muscular portion of the diaphragm; [2], central tendon or phrenic centre; [3], left crus; [4], right crus; [5], foramen venæ cavæ; [6], opening for the œsophagus; [7], do. for the aorta; [8], the posterior fibres of the true diaphragm, arising from [9], the ligamentum arcuatum; [10], psoas parvus; [11], psoas magnus; [12], quadratus lumborum; [13], iliacus internus.

F. Muscles of the Superior Extremities.

The upper extremity is connected with the trunk by the sterno-clavicular ligaments, and by eleven muscles, all of which have been already described.

Of these, one is connected to the clavicle (*subclavius*), two to the humerus (*pectoralis major* and *latissimus dorsi*), and eight to the scapula, viz. *trapezius*, *levator anguli scapulæ*, *omo-hyoid*, *rhomboides major* and *minor*, *serratus magnus*, *pectoralis minor*, and *latissimus dorsi.* The muscles of the upper extremity are classed into those of the shoulder and arm, forearm, and hand.

1. MUSCLES OF THE SHOULDER AND ARM. These muscles are hidden from view by the supra-spinous, infra-spinous, and subscapular fasciæ, and the brachial aponeurosis, which have already been briefly described. The proper muscles are six in number: the deltoid, supra and infra spinatus, teres minor and major, and the subscapularis. Those of the arm are four: the biceps, coraco-brachialis, brachialis anticus, and triceps.

The deltoides is a very thick, strong, and triangular muscle, bent so as to embrace the shoulder-joint in front, externally and behind. It arises from the lower edge of the spine of the scapula and from the anterior edge of the acromion process, and from the external third of the clavicle; its insertion is into a rough surface about two inches in extent situated on the outer side of the humerus, and commencing just above its centre. It abducts and raises the arm, draws it forwards or backwards, and rotates it inwards or outwards.

Supra-spinatus fills the fossa of the same name, and arises from all that portion of the scapula above its spine, as also from a strong fascia which covers the muscle; it is inserted into the upper and fore part of the great tuberosity of the humerus, into the most anterior and superior of the three depressions which are marked on that surface. It assists the deltoid in raising and abducting the arm, strengthens the capsular ligament, and acts as antagonist to the pectoral, deltoid, and other muscles in preventing a tendency to dislocation.

Infra-spinatus is inferior to the last, flat, and triangular. It arises from the inferior surface of the spine of the scapula and from the dorsum of this bone as far down as the posterior ridge on the inferior costa; it is inserted into the middle of the external or greater tuberosity of the humerus below the infra-spinatus. Its use is to assist the superior part of the deltoid in raising the arm, drawing it backwards, and rotating it outwards; it also serves to strengthen the articulation.

Teres minor is a small muscle inseparably attached along the lower edge of the last muscle. It arises from a depression between the two ridges on the inferior costa of the scapula, and is inserted below the infra-spinatus into the inferior depression on the great tuberosity of the humerus, and into the bone a little lower down. It co-operates with the last muscle.

Sub-scapularis is a broad, triangular muscle, situated on the inner side of the scapula opposite to the three last mentioned muscles. It arises from all the surface and circumference of the subscapular fossa, and is inserted into the interval or small tubercle of the humerus. As the strongest of the capsular muscles, it strengthens the inner side of the articulation and guards against dislocation.

Teres major, a long and flat muscle, arises from a rough flat surface on

the inferior angle of the scapula below the infra-spinatus, and is inserted into the inner or posterior edge of the bicipital groove, below the tendon of the latissimus dorsi. It rotates the humerus inwards, adducts and draws it downwards and backwards; it also draws forwards the inferior angle of the scapula.

The coraco-brachialis arises from the point of the coracoid process and from the tendon of the short head of the biceps; descending obliquely forwards, it is inserted into the inner side of the humerus, a little below the middle, and into the ridge leading to the internal condyle by an aponeurosis. It serves to adduct, raise, and draw forward the arm; also to rotate it outwards.

Biceps is situated along the fore part of the humerus, and consists of two portions superiorly, the external or long, and the internal or short. The internal arises from the coracoid process between the coraco-brachialis and the triangular ligament; the external or long head arises by a long tendon from the upper part of the glenoid cavity of the scapula; the two uniting about the middle of the humerus in a large fleshy belly, which ends in a flat tendon to be inserted into the back part of the tubercle of the radius. A process from the anterior and outer border of this tendon, called the semilunar fascia, passes to the internal condyle and to the aponeurosis of the forearm. Its use is to flex the forearm and stretch its fasciæ; also to abduct and raise the arm.

Brachialis anticus or *externus* arises from the centre of the humerus by two fleshy slips, one on either side of the insertion of the deltoid; it is inserted by a strong tendon into the coronoid process of the ulna and into a rough surface on this bone beneath that process. Use: to flex the forearm, also to strengthen the articulation when extended.

Triceps extensor cubiti covers the back of the humerus, and extends from the scapula to the olecranon; it consists superiorly of three portions, the middle or long, the second or external, and the third or internal or short head (*brachialis internus* or *posticus*). The long or middle head arises from the lower part of the neck of the scapula; the second arises immediately below the insertion of the teres minor from and behind a ridge on the outer side of the humerus, commencing below the great tuberosity and leading down to the external condyle; the third or short head arises on the inside of the humerus above its centre. These three portions unite above the middle of the arm, and descending, terminate in a broad tendon of two laminæ, a superficial and a deep; the former is continued into the fasciæ on the back part of the forearm, the latter is inserted into the posterior border but not the point of the olecranon. Use: to extend the forearm on the arm, by its long portion to carry the arm backwards, and in some cases to abduct it. The triceps is thus the great extensor of the elbow joint, while the biceps and brachialis anticus are the antagonist flexors. The flexors thus predominate over the extensors, the contrary being the case in the knee joint.

2. Muscles of the Forearm. As these muscles are very numerous, they will be most conveniently described by classing them according to their situations and use. One set is employed in bending the forearm, wrist,

and fingers: these are the *flexors*. A second, nearly allied to these, has the power of rolling the radius across the ulna, so as to turn the palm downwards: these are the *pronators*. The *extensors* can extend the forearm, hand, and fingers; and a fourth set, the *supinators*, can turn the palm of the hand upwards. The pronators and flexors arise chiefly from the internal condyle, and from the inner or ulnar side of the forearm.

The pronators and flexors arising from the inner side of the forearm are eight in number, arranged in a superficial and a deep layer. The superficial are the pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum sublimis, and flexor carpi ulnaris. The deep are the flexor digitorum profundus, flexor pollicis longus, and the pronator quadratus.

Pronator radii teres arises from the anterior part of the internal condyle and from the coronoid process of the ulna; it is inserted into the outer and back part of the radius about its centre. Use: to pronate the hand and bend the forearm.

Flexor carpi radialis arises from the inner condyle and from the intermuscular septa, and is inserted into the base of the metacarpal bone of the index finger.

Palmaris longus arises from the inner condyle, and is inserted into the annular ligament and the palmar aponeurosis. It bends the hand and stretches the palmar fascia.

Flexor carpi ulnaris arises from the internal condyle, and is inserted into the pisiform bone.

Flexor digitorum sublimis perforans arises from the internal condyle and internal lateral ligament, from the coronoid process, and from the portion of the radius below its tubercles and internal to the pronator teres. It ends in four tendons, two anterior for the middle and ring finger, and two posterior for the index and little finger; at the first phalanx of each finger, each tendon becomes inclosed in a strong sheath with one of the deep flexors. Near the end of the first phalanx, each superficial flexor tendon is split for the passage of the tendon of the deep flexor. Use: to flex the second joint of each finger on the hand, the hand on the forearm, and the forearm on the arm.

Flexor digitorum profundus perforans arises from the superior three fourths of the anterior surface of the ulna, and ends in four tendons, which pass beneath the annular ligament, and are inserted into the phalanges, as referred to when speaking of the last muscle. Use: to bend the last phalanx, and to co-operate with the superficial flexor in bending the other phalanges and the wrist.

Flexor pollicis longus arises from the fore part of the radius below its tubercle and from the interosseous membrane, to within two inches of the carpus. It is inserted into the middle of the last phalanx of the thumb, which it serves to flex.

Pronator quadratus is a small square muscle situated above the carpus, and arising from the inferior fifth of the internal and anterior surface of the ulna. It is inserted into the anterior part of the inferior fourth of the radius, and serves to roll the radius over the ulna.

The muscles situated on the outer and back part of the forearm are supinators and extensors, and may, like the last set, be arranged in a superficial and a deep layer. The superficial consists of seven: *supinator radii longus, extensor carpi radialis longus* and *brevis, extensor digitorum communis, extensor minimi digiti, extensor carpi ulnaris*, and *anconæus*. The deep muscles are five: the supinator radii brevis, three extensors of the thumb, and the indicator.

Supinator radii longus, forming the prominence along the outer and anterior part of the forearm, arises from the external ridge of the humerus, and from the intermuscular ligament separating it from the outer head of the triceps. It is inserted into a rough surface on the outside of the radius, near its styloid process. It serves to roll the radius backwards and to bend the elbow joint.

Extensor carpi radialis longus arises from the ridge on the external side of the humerus, and is inserted into the back part of the metacarpal bone of the index finger.

Extensor carpi radialis brevis arises from the inferior and posterior part of the external condyle, and from the external lateral ligament; it is inserted into the carpal extremity of the third metacarpal bone (that of the middle finger).

Extensor digitorum communis arises with the last and the extensor minimi digiti, from the external condyle and from the ulna. About the middle of the back of the forearm it ends in four muscles, each ending in tendons, which pass under the annular ligament and are inserted into the phalanges of the four fingers. It serves to extend all the joints of the fingers, as also the carpus.

Extensor carpi ulnaris arises from the external condyle, fascia, and intermuscular septa, and ends in a strong tendon, which is inserted into the carpal end of the fifth metacarpal bone. It extends and bends back the hand, and adducts or flexes it laterally towards the ulna.

Anconæus is placed at the outer side of the olecranon, beneath the skin, and arises from the posterior and inferior part of the external condyle and lateral ligament, and is inserted into the external surface of the olecranon, and the superior fifth of the posterior surface of the ulna. Its use is to extend the forearm on the arm.

Extensor minimi digiti vel auricularis arises in common with the extensor communis, and is inserted with the fourth tendon of this muscle into the posterior part of the phalanges of the little finger. It assists the extensor communis, and can extend and abduct the little finger independently of the rest.

Supinator radii brevis surrounds the upper part of the radius: it arises from the external condyle, external, lateral, and coronary ligaments, and from the outer side of the ulna, and is inserted into the external and anterior surface of the radius. It turns the radius outwards, so as to supinate the hand.

Extensor ossis metacarpi pollicis, or *abductor pollicis longus*, arises from the middle of the posterior part of the ulna and posterior surface of the

radius, and is inserted by two tendons, one into the trapezium bone, the other into the upper and back part of the metacarpal bone of the thumb. It serves to extend the first joint of the thumb, and to separate it from the fingers. It also assists in supination.

Extensor primi internodii pollicis, or *extensor minor*, arises from the back part of the ulna, below its middle, and from the interosseous ligament and the radius; it is inserted into the posterior part of the first phalanx. It serves to extend the second joint of the thumb, and to assist the last mentioned muscle.

Extensor secundi internodii pollicis, or *extensor major*, arises from the posterior surface of the ulna, above its centre, and from the interosseous membrane; it is inserted into the posterior part of the second or last phalanx; it extends the last phalanx of the thumb upon the first.

Extensor indicis, or *indicator*, arises from the middle of the posterior surface of the ulna and interosseous membrane, and is inserted into the second and third phalanges of the fore finger. It assists the common extensor, or produces the extension of the fore finger alone, as in pointing.

3. Muscles of the Hand. These consist principally of the short muscles of the thumb and of the little finger, of the lumbricalis, and of the interosseous muscles.

The short muscles of the thumb are four in number, *abductor pollicis*, *opponens pollicis*, *flexor pollicis brevis*, and *adductor pollicis*, whose names sufficiently indicate their use.

The muscles of the little finger are three, *abductor minimi digiti*, *flexor brevis minimi digiti*, and *adductor* or *opponens minimi digiti*.

The *palmaris brevis* is placed just below the skin, at the inner side of the palm of the hand; it consists of separate fasciculi which arise from the anterior ligament of the wrist, and is inserted into the skin and fat at the inner margin of the hand. It is used in hollowing out the palm.

The *lumbricales* are four in number, and arise from the radial sides of the tendons of the flexor profundus. They terminate in little flat tendons, which are inserted into the tendinous expansion of the extensor communis on the back of the first phalanx of each finger; they serve to bend the first phalanges.

The interosseous muscles, seven in number, fill up the interstices of the metacarpal bones; four belong to the palm, and three to the back of the hand. They arise from the base and sides of the metacarpal bones, and are inserted into the sides of the first phalanges, and into the tendinous membrane on the back part of the fingers. The palmar are the *prior indicis*, the *posterior indicis*, the *prior annularis*, and the *interosseus digiti auricularis*. The dorsal are the *prior medii*, the *posterior medii*, and the *posterior annularis*.

Pl. 124, *fig.* 15 [17], deltoides; [18], pectoralis major; [19], biceps; [20], pronator teres; [21], flexor sublimis digitorum; [22], supinator longus; [23], flexor carpi radialis. *Fig.* 16 [5], deltoides; [7], triceps; [8], extensor digiti minimi; [9], extensor carpi ulnaris; [10], extensor communis digitorum; [11], abductor pollicis longus; [12], extensor pollicis brevis; [13], extensor pollicis longus; [14], external interosseous

muscles; [15], tendons of the extensor communis digitorum. *Fig.* 17 [4], deltoides.

Pl. 125, *fig.* 19 [15], biceps; [16], flexor digitorum communis sublimis; [17], extensor pollicis longus. *Fig.* 20 [6], supra-spinatus; [7], infra-spinatus; [8], teres minor; [16], triceps extensor cubiti; [17], brachialis internus; [18], anconæus; [19], extensor carpi radialis; [20], flexor carpi ulnaris; [21], extensor pollicis longus; [22], indicator; [23], abductor pollicis longus; [24], extensor pollicis brevis.

Pl. 126, *fig.* 20 [8], coraco-brachialis; [9], biceps; [10], flexor digitorum profundus; [11], flexor pollicis longus. *Fig.* 21 [14], anconæus; [15, 16], exterior carpi radialis longus et brevis.

Pl. 127, *fig.* 12 [1], supra-spinatus; [2], infra-spinatus; [3], teres minor; [4], teres major; [5], end of latissimus dorsi. *Fig.* 13 [1], subscapularis; [2], biceps; [3], coraco-brachialis; [4], brachialis internus; [6], teres major. *Fig.* 14 [1], tendon of the triceps; [2], brachialis internus. *Fig.* 15 [1], deltoid; [2], common tendon of the triceps; [3, 4, 5], the long, the external, and the internal portions; [6], anconæus.

Pl. 128, *fig.* 4 [1], pronator teres; [2], flexor carpi radialis; [3], palmaris longus; [4], flexor carpi ulnaris; [5], supinator longus; [6], flexor digitorum communis. *Fig.* 5 [1], flexor digitorum communis sublimis; [2], slit for the passage of the flexor profundus; [3], supinator longus; [4], lower part of the brachialis internus; [5], tendon of the biceps; [6], palmar ligament. *Fig.* 6 [1], flexor communis digitorum profundus; [2, 3], flexor pollicis longus; [4], pronator quadratus; [5] and [6], supinator longus et brevis. *Fig.* 7 [1], extensor digitorum communis; [2], extensor digiti minimi; [3], extensor carpi ulnaris; [4], anconæus; [5], extensor carpi radialis longus et brevis; [6], annular ligament. *Fig.* 8 [1], supinator brevis; [2], anconæus reflected; [3], abductor longus pollicis; [4], extensor pollicis brevis; [5], extensor pollicis longus; [6], extensor indicis. *Fig.* 9 [1], tendon of the extensor pollicis longus; [2], tendon of the palmaris longus; [3], tendon of the flexor carpi ulnaris; [4], abductor pollicis brevis; [5], opponens pollicis; [6], flexor pollicis brevis; [7], abductor pollicis; [8], palmaris brevis; [9], abductor digiti minimi; [10], flexor brevis digiti minimi; [11], opponens digiti minimi; [12], internal interosseous muscle. *Fig.* 10 [1, 2, 3], external interosseous muscles.

G. Muscles of the Inferior Extremities.

Each inferior extremity is connected to the trunk by the strong ligaments of the hip joint, and by several muscles which pass from the pelvis to the thigh and leg. The muscles of the lower extremities may be conveniently classed into those of the pelvis or hip joint, thigh, leg, and foot; those of the thigh are arranged into posterior, anterior, external, and internal.

1. Muscles of the Hip. These are nine in number: the three glutæi, the pyriformis, the gemini, the two obturators, and the quadratus femoris.

Glutæus maximus covers the greater part of the pelvis, also the upper part of the thigh; it is somewhat square, with the inferior edge thick and

round, and covered by a great quantity of fat; this forms the fold of the nates. It arises from the posterior fifth of the crest of the ilium, from the rough surface between the crest and the superior semicircular ridge of this bone, from the posterior surface of the sacrum, and from the sides of the coccyx. The flat and thick tendon of this muscle is inserted into a rough ridge, which leads from the trochanter to the linea aspera; also into the upper third of that line, and into the fascia lata. Use: to extend the thigh, to abduct and rotate it outwards, and to support and extend the pelvis and the trunk on the lower extremity.

Glutæus medius, triangular, and thinner than the last, arises from the three anterior fourths of the outer edge of the crest of the ilium, and from the surface of the ilium, and is inserted into the upper and outer part of the great trochanter, being also attached anteriorly to the tendon of the glutæus maximus. Use: to abduct and rotate the thigh, and to maintain the pelvis in equilibrium on the femur.

Glutæus minimus arises from the inferior semicircular ridge on the dorsum of the ilium, and from the rough surface between it and the edge of the acetabulum. The fibres converge and end in a strong, round, twisted tendon, which is inserted into the upper and anterior part of the great trochanter. Use: similar to the last. It also strengthens the ilio-femoral articulation.

Pyriformis is a flattened triangular muscle, the base at the sacrum within the pelvis, the apex at the trochanter. It arises within the pelvis, and is inserted into the upper part of the digital fossa at the root of the great trochanter. Use: to abduct the thigh, to extend and rotate it outwards.

Gemelli, two smaller muscles, placed behind the ilio-femoral articulation, between the ischium and trochanter. The superior arises from the spine of the ischium, and is inserted into the upper part of the digital fossa of the great trochanter. The inferior arises from the upper part of the tuber ischii, and is also inserted into the digital fossa. Use: to rotate the thigh outwards and to abduct it.

Obturator internus is situated partly within the pelvis and partly behind the ilio-femoral articulation. It arises within the pelvis from the superior surface of the thyroid ligament and from the circumference of the thyroid foramen, and is inserted into the digital fossa of the great trochanter. Use: to abduct and rotate the thigh outwards; also to act on the capsular ligament.

Quadratus femoris arises from the external surface of the tuber ischii, anterior to the tendon of the semi-membranosus. It is inserted into the inferior and posterior part of the great trochanter, and into the posterior inter-trochanteric line. Use: to abduct and rotate the thigh outwards.

Obturator externus, situated at the upper, posterior, and internal portion of the thigh, arises from the inferior surface of the thyroid or obturator ligament, and from the surrounding surfaces of the pubes and ischium. It is inserted into the lower part of the digital fossa. Use: to adduct the thigh and rotate it outwards.

2. Muscles of the fore part and sides of the Thigh. These are eleven in number.

Tensor vaginæ femoris arises from the exterior internal part of the anterior superior spinous process and crest of the ilium, and is inserted into a duplicature of the fascia lata on the outside of the thigh, about three or four inches below the great trochanter. Use: to make tense the fascia, to compress the vastus externus, to rotate the thigh inwards, and to assist in flexing and abducting it.

Sartorius, or the tailor's muscle, is the longest muscle in the body. Thin and flat, like a ribbon, it is situated obliquely along the anterior and inner side of the thigh, arising from the anterior superior spine of the ilium and from the notch below that process. It extends obliquely across the thigh to its inner side, and descending perpendicularly to the knee, it passes behind the condyle of the femur. It then turns forwards and outwards towards the inner side of the upper end of the tibia, into which it is inserted below the tubercle. Use: to flex the leg on the thigh and the thigh on the pelvis, to cross the lower extremities, &c.

Rectus femoris is a long and flat muscle, placed vertically on the fore part of the thigh. It arises by two tendons, one from the anterior inferior spinous process of the ilium, the other from the superior and external border of the acetabulum. These soon unite into a strong fleshy belly ending in a flat tendon, which is inserted into the upper edge of the patella. Use: to extend the leg on the thigh and to flex the leg on the pelvis. Its action is greatly facilitated by the patella, which enables it to act at greater mechanical advantage. This muscle is internally united to three others subjacent to it; the four, in fact, form a single quadriceps muscle. Of these the external is called vastus externus, the middle, cruræus, and the internal, vastus internus.

The *vastus externus* arises from the root and anterior part of the great trochanter, from the outer edge of the linea aspera, and from the oblique ridge which leads to the external condyle. It is inserted into the external surface of the tendon of the rectus, and into the patella. It extends the knee, and rotates the leg outwards.

Vastus internus arises on the anterior edge of the femur, and is inserted into the inner edge of the tendon of the rectus and into the patella. Use: to extend the knee and turn the leg a little inwards.

Cruræus, between the two last, arises from the anterior and external part of the femur, and is inserted into the upper and anterior edge of the patella. It assists the vasti and rectus in extending the leg.

Gracilis, situated at the inner side of the thigh, beneath the integuments and fasciæ, arises from the lower half of the symphysis and from the inner edge of the descending ramus of the pubes. It is inserted into the superior part of the internal surface of the tibia. Use: to abduct the leg and thigh, to bend the knee, and turn the leg and foot inwards.

Pectinæus arises from the linea innominata and the convex surface below it on the horizontal ramus of the pubes, and is inserted into the rough ridge

leading from the lesser trochanter to the linea aspera. Use: to adduct and flex the thigh and to rotate it inwards.

Triceps adductor femoris consists of the three following portions, which pass in distinct laminæ from the pelvis to the thigh:

Adductor longus, flat and triangular, situated at the upper and internal part of the thigh, arising from the anterior surface of the pubes, and inserted into the middle third of the linea aspera.

Adductor brevis, arising from the anterior inferior surface of the pubes, and inserted into the superior third of the internal root of the linea aspera.

Adductor magnus, the largest and longest of the three, arising from the anterior surface of the descending ramus of the pubes, and from the ramus of the ischium, and inserted into the rough ridge leading from the great trochanter to the linea aspera. The three adductors, in addition to adducting the limb, can rotate it outwards. They also serve to support and steady the pelvis on the thigh; likewise to flex and extend the thigh on the pelvis.

3. Muscles of the back part of the Thigh. They are only three in number, and are commonly called hamstrings; the semi-tendinosus and semi-membranosus form the inner, the biceps the outer hamstring.

Biceps flexor cruris consists of a long and a short head. The former arises from the outer and back part of the tuber ischii in common with the semi-tendinosus, and about the inferior third of the thigh it joins the short head which arises from the linea aspera. The tendon of the common muscle descends behind the knee, then turning forwards and outwards, is inserted into the head of the fibula. Use: to flex the knee joint, to extend the thigh, and rotate the limb outwards. It also assists in raising the body when bent in, and in maintaining the erect posture.

Semi-tendinosus arises from the tuberosity of the ischium, and is inserted into the anterior angle of the tibia below its tubercle. Use: to flex the knee, and rotate the leg inwards; also to extend the thigh, to support the pelvis, and prevent the trunk from bending forwards.

Semi-membranosus, beneath the preceding, arises from the upper and outer part of the tuber ischii, and descending ends in a tendon, which passes behind the internal condyle and divides into three processes. The first is inserted into the external condyle of the femur; the second is inserted into the posterior part of the tibia and fibula, and is also continuous with the deep fascia of the leg; the third is inserted into the head of the tibia. Use: to extend the thigh on the leg, to flex and rotate the knee, and to strengthen the back part of the joint.

4. Muscles of the anterior and external part of the Leg. The muscles on the fore part of the leg are four in number, viz. the tibialis anticus, extensor pollicis, extensor communis digitorum, and peronæus tertius. Those on the outer side of the leg are the peronæus longus and brevis.

Tibialis anticus, on the outer side and next to the tibia, arises from the outer part of the superior two thirds of the tibia, from the head of the fibula, and from the interosseous ligament; it is inserted into the inner side of the

great or internal cuneiform bone, as also into the base of the great toe. Use: to flex the ankle, to adduct the foot, to turn the toes inwards, and to support the leg when standing.

Extensor digitorum longus arises from the external part of the head of the tibia, and from the upper part of the fibula, and is inserted by four tendons into the back of the last phalanx of each toe (except the great toe). Use: to extend the toes and flex the ankle.

Extensor pollicis proprius arises from the inner edge of the middle third of the fibula, and is inserted by two tendinous fasciculi, one into the base of the first phalanx, and the other into the base of the second or last phalanx of the great toe. Use: to extend the great toe and flex the ankle.

Peronæus tertius or *anticus* arises from the anterior surface of the lower half of the fibula, and is inserted into the base of the fifth metatarsal bone. Use: to extend the little toe, to flex the ankle, and to raise the outer edge of the foot.

Peronæus longus arises from the head of the fibula and from the adjacent surface of the tibia; it is inserted into the outer side of the metatarsal bone of the great toe and into the adjacant sesamoid bone. Use: to extend the ankle joint, to press the great toe against the ground as in walking, and to turn the foot outwards.

Peronæus brevis arises from the lower half of the fibula, and is inserted into the base of the metatarsal bone of the little toe and into the os cuboides. It is similar to the last in its uses.

5. Muscles of the back part of the Leg. These are seven in number, arranged in a superficial and a deep layer; the former consists of the gastrocnemius, soælus, and plantaris; the latter, of the tibialis posticus, flexor pollicis longus, flexor digitorum communis, and poplitæus.

Gastrocnemius arises by two heads, one from a digital depression on the upper and back part of the internal condyle of the femur, the other from above the external condyle. The two fleshy bellies form the calf of the leg, these ending in a broad flat tendon about the middle of the limb, which with the tendon of the subjacent solæus is inserted into the lower and back part of the os calcis, as the tendo achillis. Use: to extend the ankle joint, and to throw the whole weight of the body forward on the toes, as in progression.

Plantaris arises from the back part of the femur, above the external condyle and from the posterior ligament of the knee; it is inserted into the os calcis a little anterior to the tendo achillis. Use: to extend the foot and turn it inwards; also to flex the knee.

Solæus arises from the back part of the tibia and fibula by two slightly developed heads, and is inserted into the os calcis by the tendo achillis, common to it and the gastrocnemius. It assists in extending the ankle, but can exert no influence on the knee joint.

Poplitæus arises from a depression on the external surface of the outer condyle, and is inserted into a flat triangular surface which occupies the superior fifth of the posterior surface of the tibia. Use: to bend the knee, and when bent to twist the foot inwards.

Flexor digitorum perforans arises from the posterior flat surface of the tibia, and is inserted by four tendons into the base of the last phalanx of each of the four lesser toes. Use: to flex the metatarsus and all the phalanges of the toes.

Tibialis posticus arises from the posterior and internal part of the fibula, and is inserted into a tuberosity on the inferior and internal part of the os naviculare. Use: to extend the ankle, and to raise the inner edge of the foot from the ground.

Flexor pollicis longus arises mainly from the two inferior thirds of the fibula, and is inserted into the base of the last phalanx of the great toe. Use: to flex this toe, to extend the ankle, and to adduct the foot.

6. MUSCLES OF THE FOOT. There is but one muscle in the upper surface of the foot, the extensor digitorum brevis. Those in the sole of the foot are very numerous, and may be divided into four laminæ. The muscles of the first lamina are, the abductor pollicis, flexor digitorum brevis, and abductor minimi digiti; in the second layer are the long flexor tendons, the accessory muscle, and the lumbricalis. The third layer consists of the flexor pollicis brevis, adductor pollicis, transversalis pedis, and flexor minimi digiti. In the fourth are the interosseous and the tendon of the peronæus longus.

Extensor digitorum brevis arises from the upper part of the os calcis, from the cuboid bone, the astragalus, and the annular ligament; it ends in four tendons, which are inserted into the upper part of all the four large toes. It serves to extend the toes and to rotate the anterior part of the foot outwards.

Abductor pollicis arises mainly from the inner part of the os calcis, and is inserted into the internal sesamoid bone, and into the internal side of the first phalanx of the great toe. It serves to flex the great toe and to separate it from the rest.

Flexor digitorum brevis perforatus arises from the inferior and internal part of the os calcis, and about the middle of the foot divides into four muscles, each ending in tendons. Each tendon is perforated by the long flexor tendon, and is ultimately inserted into the lateral borders of the second phalanges. It assists to preserve the arch of the foot, and helps the long flexor muscle.

Abductor minimi digiti arises principally from the outer side of the os calcis, and is inserted into the outer side of the base of the first phalanx of the little toe and into the adjoining surface of the metatarsal bones. It flexes the little toe and separates it from the others.

Accessorius arises bifurcated from the inferior and lateral borders of the os calcis, and is inserted into the upper and outer part of the tendon of the flexor digitorum longus just before it divides. It assists the long flexor, and counteracts its obliquity.

Lumbricales are four small muscles which arise from the angles between the tendons of the flexor digitorum longus; each is inserted into the internal side of the first phalanx of the four toes, there being none for the great toe. They adduct and assist in flexing the four toes.

Flexor pollicis brevis arises from the anterior inferior part of the os calcis,

and from the cuboid and external cuneiform bone, and passing forwards is divided into two tendons inserted into the sesamoid bones beneath the first phalanx of the great toe. It flexes the first joint of the great toe, and approximates this toe to the others.

Adductor pollicis arises from the calcaneo-cuboid ligament and from the base of the second, third, and fourth metatarsal bones; it is inserted into the external sesamoid bone. It draws the great toe outwards towards the others, and flexes it so as to bring it beneath them.

Transversalis pedis arises by distinct slips from the anterior extremities of the four external metatarsal bones. It is inserted into the external sesamoid bone of the great toe along with the last mentioned. It approximates the toes and contracts the arch of the foot.

Flexor brevis minimi digiti arises from the cuboid and fifth metatarsal bones, and is inserted into the inner side of the base of the first phalanx of the little toe, which it serves to flex and adduct.

The *interossei muscles* are seven in number; three are seen on the sole and four on the dorsum. The inferior are *adductor medii digiti*, *adductor quarti digiti*, and *adductor minimi digiti*. They arise from between the metatarsal bones of the four external toes, and are inserted into the inner side of the base of the first phalanx of the three lesser toes. The superior interossei are all abductors, viz. *internus digiti secundi*, *externus digiti secundi*, *abductor digiti medii*, and *abductor digiti quarti*.

Pl. 124, *fig.* 15 [29], tensor vaginæ femoris; [30], pectinæus; [31], sartorius; [32], gracilis; [33], rectus femoris; [34], ligamentum patellæ; [35], extensor digitorum communis; [36], tibialis anticus. *Fig.* 16 [17], glutæus maximus; [18], gracilis; [19], vastus externus; [20], biceps flexor cruris; [21], gastrocnemius.

Pl. 125, *fig.* 19 [28], extremity of the psoas and iliacus externus; [29], adductor brevis; [30], adductor longus; [31], cruræus; [32], vastus externus; [33], vastus internus; [34], extensor digitorum communis; [35], extensor longus pollicis. *Fig.* 20 [31], plantaris; [32], solæus; [33], tendon of the gastrocnemius.

Pl. 126, *fig.* 20 [19], quadratus lumborum; [20], psoas parvus; [21], psoas magnus; [22], iliacus internus; [23], adductor brevis; [24], adductor longus; [25], adductor magnus; [26], gracilis. *Fig.* 21 [26], glutæus minimus; [27], obturator internus; [28], obturator externus; [29], adductor magnus; [31], poplitæus; [32], flexor digitorum communis; [33], flexor pollicis longus; [34], peronæus longus; [35], peronæus brevis; [36, 37], tibialis posticus.

Pl. 128, *fig.* 11 [1], glutæus maximus; [2], glutæus medius. *Fig.* 12 [1], glutæus medius; [2], pyriformis; [3], tendon of the obturator internus; [4], quadratus femoris; [5], section of the tendon of the glutæus maximus. *Fig.* 13 [1], section of the pyriformis; [2], glutæus minimus; [3], obturator internus; [4], quadratus femoris; [5], adductor femoris; [6], biceps flexor cruris; [7], semi-tendinosus; [8], semi-membranosus. *Fig.* 14 [1], psoas magnus, [2], iliacus internus (both in section); [3], sartorius; [4], tensor vaginæ femoris; [5], rectus; [6], vastus externus; [7], pectinæus; [8], adductor longus; [9], gracilis. *Fig.* 15 [1], the four extensors of the leg, the rectus supposed to be cut off: [2], adductor brevis; [3], adductor magnus; [4], obturator externus. *Fig.* 16 [1], tibialis anticus; [2], extensor pollicis longus; [3], extensor digitorum com-

munis; [4] and [9], peronæus longus; [5] and [8], peronæus brevis; [6], extensor communis brevis; [3'] and [7], peronæus tertius; [10], annular ligament on the back of the foot. *Fig.* 17 [1], flexor digitorum brevis; [2], abductor pollicis; [3], flexor pollicis brevis; [4], abductor digiti minimi; [5], flexor brevis digiti minimi. *Fig.* 18 [1], flexor pollicis brevis; [2], adductor pollicis; [3], transversalis plantaris; [4], tendon of the peronæus longus. *Fig.* 19 interosseous muscles of the back of the foot.

III. THE VASCULAR SYSTEM.

(ANGEIOLOGY.)

The Vascular System consists of membranous ramifying tubes, which conduct either blood or fluids to be added to the blood for the sake of restoring to it the materials necessary for its normal functions. The blood, from which is derived the material of life and growth, is furnished by the food taken into the stomach, which after undergoing certain operations, subsequently to be explained, and after being strained through exceedingly fine tubes called lacteals, is introduced into the general circulation by the thoracic duct. The blood circulates through all parts of the body mainly by the impulsion of a central engine, the heart, which continues pulsating at regular intervals during the entire life of the animal. Vessels which conduct blood from the heart are known as arteries, while those which bring it back again are veins. The former are distinguishable from the latter by their exhibiting the phenomena of pulse. The arteries pass to all parts of the body, dividing and subdividing continually as they recede from the heart, until finally they end in ramifications so fine as only to be appreciable by the microscope. These terminal branches are called *capillaries.* The capillaries are continued into the veins, which present an appearance much like that of the arteries, viz. a tree excessively ramifying, with the trunk resting on the heart, and the branches ending in the capillaries, which latter thus constitute the peripherical medium of communication between the arteries and the veins. The blood proceeds from the heart through the arteries to the capillaries, where it undergoes certain changes; passing into the veins from these, it again reaches the heart, thus performing a round known as the circulation of the blood. The nutritious particles of the blood pass through the thin walls of the capillaries into the various tissues, for the sake of supplying the wear and tear of animal life; the dead or effete portions are taken up in the state of lymph by another set of vessels called lymphatics, which discharge their contents into the veins, ultimately to be subjected to certain influences which prepare them for again playing their part in the general circulation. The chyliferous system is closely allied to the lymphatic. This consists of excessively minute canals, which extend from the intestines to the thoracic duct, and are called lacteals, on account of their white appearance when distended with the milk-like chyle.

The blood, when returned from the capillaries through the veins, is no longer fit for the purposes of life, and must accordingly be purified, or freed from the dead matters with which it is loaded. This purification is mainly effected through the instrumentality of the lungs, in which the venous blood comes in contact with the atmosphere and constitutes respiration. In the lungs, the oxygen of the air is absorbed by the blood, and uniting with the superabundant carbon, forms carbonic acid, which, as a gas, may be exhaled. The accession of oxygen converts the dark venous blood into the bright red arterial, which again returning to the heart, is impelled into the arteries as before. This union of the carbon of the blood with oxygen absorbed from the air, takes place not only in the lungs but in the bloodvessels. The circulation of the blood through the arteries, capillaries, and veins, is known as the greater or systematic circulation, that through the lungs being the lesser or pulmonic

1. Special Anatomy of the Heart.

The central organ of the vascular system, the *heart*, is a hollow, irregularly conical body, slightly flattened posteriorly, and so situated in the thoracic cavity between the two lungs, as that its base from which the bloodvessels arise is superior, and the apex directed downwards and to the left.

The heart does not lie loose in the thorax, but is inclosed in a membranous bag called the *pericardium*. The external or fibrous layer is closely united to the pleura or lining membrane of the thorax, and to the mediastinum, a nearly vertical partition formed by the juxtaposition of the pleuræ of opposite sides. Although, on the whole, of similar shape to the heart, it is yet inverted, the apex being superior and the base inferior. Below it is firmly united to the tendon of the diaphragm. It consists essentially of two layers, an external or fibrous, and an internal or serous. The serous layer is reflected over the heart, and secretes a thin yellowish fluid, the liquor pericardii, which lubricates the heart, and permits it to play freely within its pericardium. The amount of this liquor when in health seldom exceeds a teaspoonful.

The heart is a strong muscular bag, divided into two compartments, two auricles and two ventricles. On looking at it from before, there will be seen a longitudinal furrow, *sulcus longitudinalis*, which divides it into right and left portions; this furrow corresponds to the internal partition dividing the right auricle and ventricle from the left auricle and ventricle. A second furrow, *sulcus transversalis* or *coronalis*, intersects the first at right angles, and marks the partition between the right and left auricle and the right and left ventricle. The two auricles form the base of the heart, the ventricles constituting its body; and the anterior end of the left ventricle, by being extended somewhat beyond the right, forms the apex. The auricles are in immediate connexion with the great venous trunks; the right with the two venæ cavæ, the left with the pulmonary veins, all of which conduct blood to the heart.

The interior of the heart is provided with a serous layer or membrane, as well as the exterior. This, which is known as the *endocardium*, not only constitutes a smooth lining to the cavities of the heart, and thus greatly facilitates the passage of the blood, but, by its duplicatures, it forms the valves which are situated in the openings in the heart, and regulate the proper flow of the blood. Starting from the entrance of the two venæ cavæ, it enters the right auricle, and there forms the eustachian and coronary valves; passing through the opening between the right auricle and ventricle, it increases in density, and forms the loose pendulous tricuspid valve. Approaching the orifice of the pulmonary artery, it assists in forming the sigmoid valves, and becomes continued into the lining internal coat of that vessel and its ramifications. In like manner, through the left cavities of the heart we can trace it from the pulmonary veins into the left auricle, thence into the left ventricle and aorta, forming in its course the mitral and semilunar valves.

On removing the serous investment of the exterior of the heart, we come to the muscular tissue, which will be seen to be much thicker over the ventricles than over the auricles, and over the left ventricle than over the right.

Considering, in the next place, the individual cavities of the heart, we commence with the *right auricle*. This constitutes an oblong cuboidal cavity, joined at its posterior superior angle by the descending vena cava, and at its posterior inferior angle by the ascending vena cava. The structure of the auricle between these two points appears to be only a continuation of that of the veins. In front of this continuation of the two veins the auricle is dilated into a pouch, called its sinus, the upper extremity of which is elongated into a process with indented edges, somewhat resembling the ear of an animal, whence the term auricle. About midway between the orifices of the two venæ cavæ is seen a transverse prominence, the *tuberculum Loweri*. This cavity is separated from the left auricle by a thin partition common to the two auricles. On the septum or partition, below its middle, is a superficial circular depression, the *fossa ovalis*, surrounded by an elevated margin, called the *annulus*. In the fœtus, before birth, this fossa is occupied by a hole, *foramen ovale*, through which the blood passes directly from the right to the left auricle, without first going through the lungs.

Just below the fossa ovalis is seen the *Eustachian valve*, which in the fœtus serves to direct the blood to the foramen ovale; in the adult it appears to oppose the reflux of blood into the ascending vena cava at the lower part of the right auricle; to the left of the Eustachian valve is seen the orifice of the large coronary vein of the heart, protected by a small semilunar valve, *valvula Thebesii*. Between the right auricle and ventricle is a round hole, about an inch in diameter, called the *ostium venosum*, or right auriculo-ventricular opening, for the passage of the blood. This is surrounded by a dense white line, designated as the right tendon of the heart.

The walls of the right auricle are formed by muscular fibres. On the sinus these are collected into small transverse fasciculi, called *musculi pecti-*

nati, which leave between them deep interstices, in which the external and internal membranes of the heart come in contact.

The *right ventricle.* This forms the greater part of the anterior surface of the heart, and is separated posteriorly from the left ventricle by a thick septum. The internal surface of the cavity of the right ventricle is covered by muscular fasciculi, known as the *columnæ carneæ*, some of them passing from one side to the other, and others contributing to the valvular arrangement between the right auricle and ventricle. These, called *chordæ tendineæ*, pass to the edge of the *tricuspid valve*, which arises from around the margins of the ostium, and projects into the cavity of the ventricle.

The opening for the pulmonary artery is situated above the ostium venosum. It is round, and about an inch in diameter, and furnished with three valves, called *semilunar* and *sigmoid*, which are capable of completely closing this orifice, should the blood flow back from the pulmonary artery, but which lie close pressed to the sides when the current is in its normal direction. Through the pulmonary artery venous blood is carried to the lungs.

The blood, after circulating through the lungs, is returned by the pulmonary veins into the *left auricle*, at the anterior inferior side of which is seen the left auriculo-ventricular opening, or the communication with the left ventricle, about an inch in diameter. This, like the right auricle, is constituted by a sinus venosus and auricular appendage.

The *left ventricle* constitutes the principal bulk of the heart, and its walls are nearly three times as thick as those of the right ventricle. Its internal surface is roughened by the same columnæ carneæ as the right. The ostium venosum, or opening between the left ventricle and auricle, is on the side also fortified by a valvular arrangement, the *mitral valve*, which prevents the reflux of blood. It is retained in the left ventricular cavity by chordæ tendineæ. Close to the ostium is the opening for the aorta, guarded by three semilunar valves, very similar in arrangement to those of the pulmonary artery, being, however, stronger.

Passage of blood through the heart. By the alternate contraction and dilation of the different chambers of the heart, the blood is caused to circulate through it and the bloodvessels proceeding from it. The right and left ventricles contract, while the two auricles expand, and vice versâ; contraction of the ventricles being known as the *systole*, and their dilation the *diastole*. Commencing with the right side of the heart, we find that when the auricle contracts, the blood is forced towards the auriculo-ventricular opening, and backwards into the venæ cavæ. The simultaneous expansion of the right ventricle, however, affords a free passage for the blood from the right auricle, which accordingly rushes through the ostium. The ventricle now contracting, forces the blood towards the ostium, and towards the pulmonary artery. Through the former it cannot pass, by reason of the tricuspid valve; and as the semilunar valves at the entrance of the pulmonary artery afford no impediment, the blood is drawn into the lungs. Simultaneously with this contraction of the ventricles, the right auricle dilates and becomes filled with fresh venous blood from the venæ cavæ.

The blood, after passing through the lungs, is brought back to the left auricle, which, contracting at the moment when the left ventricle is expanding, forces the blood into the left ventricle. The contraction of this ventricle drives the blood into the aorta, its reflux into the auricle being prevented by the mitral valve. The semilunar valves of the pulmonary artery and aorta prevent the reflux of blood into their respective ventricles.

Pl. 130, *fig.* 1, right half of the heart from before: [1], right auricle; [2], right ventricle. *Fig*, 2, left half of the heart from before: [1], left auricle; [2], left ventricle. *Fig.* 4, larynx, trachea, pericardium, and lungs: [5], pericardium. *Fig.* 5, heart from before: [1], right sinus; [2], right auricular appendage (the two constituting the auricle); [3], superior vena cava; [4], inferior vena cava; [5, 6], left sinus and appendage, or left auricle; [7, 8], pulmonary veins; [9], sulcus transversalis; [10], longitudinal furrow or fissure; [11], right ventricle; [12], pulmonary artery; [13], left ventricle; [14], aorta. *Fig.* 6, section of the right half of the heart: [1], right auricle; [2], fossa ovalis; [3], Eustachian valve; [4], opening of the great coronary vein with the valvula Thebesii; [5], right ventricle with its columnæ carneæ; [6], a point of the tricuspid valve with the chordæ tendineæ; [7], pulmonary artery with two of the semilunar valves. *Fig.* 7, section of the left half of the heart: [1], left auricle with the openings of the pulmonary veins; [2], left ventricle; [3], mitral valves; [4], aorta with two semilunar valves. *Fig.* 8, direction of the muscular fibres of the heart: [1, 2, 3], fibres of the auricles; [4], fibres of the ventricles; [5], openings for the large vessels of the heart; [6], place where the fibres twist round each other at the apex, to become united with the deep layers; [7], place where the superficial anterior and posterior fibres interlace and become united with the deep fibres; [8, 9], openings of the pulmonary artery and aorta.

2. Special Anatomy of the Arteries.

The *aorta*, situated on the base of the heart, may be considered as the main trunk of a tree, whose ramifications ever increasing constitute the arteries, the ultimate branches being the capillaries. The various arterial divisions are named partly from their regional situation, as subclavian, axillary, &c., partly from their relative position, as deep or superficial, and partly from their distinction, as cerebral, ophthalmic, &c. The names "aorta" and "artery" show the opinion entertained by the ancients with respect to their functions, being supposed to conduct vital air exclusively, from being found empty of blood after death, yet still distended.

The arterial tubes are of a dense structure, and when empty preserve their form without collapsing. They are composed of three principal coats or tissues. The *first* or *external* is fibro-cellular, strong and resisting, and connects the vessels with the surrounding parts. The *second*, or *middle*, or *proper coat* of the arteries is thickest, and consists of yellowish and rather dry fibres, elastic but not brittle; although circular they do not form com-

plete rings. By the aid of the microscope, this coat may be divided into three laminæ: an external, thin, elastic, and yellow; a middle, composed of circular fibres similar to those of unstriped involuntary muscle; and an internal, similar to the last, but with the fibres longitudinal. The *internal coat* of an artery is smooth and polished, and may be subdivided into two laminæ, the internal composed of tesselated epithelium, and resting on a basement membrane with longitudinal and internal fibres. Although the external system is devoid of exact symmetry, yet, with a few exceptions, one description will apply to either side. Arteries are all supplied with nutrient vessels and nerves from the adjacent parts.

A. The Arch of the Aorta.

The aorta, arising from the superior posterior end of the left ventricle, passes beneath the pulmonary artery, and is entirely concealed in front by it. Keeping to the right, it emerges at the base of the heart, between the right auricle and the trunk of the pulmonary artery, being bounded on the right side by the descending vena cava. Continuing its ascent, it forms a curvature with the convexity upwards, the summit of which arises to within about an inch of the superior edge of the sternum. This curvature is in front of the third and fourth dorsal vertebræ, and in its course the aorta passes over the right pulmonary artery, across the left bronchus, and applies itself to the left side of the spine about the third or fourth dorsal vertebra. This bend is known as the aortic arch, *arcus aortæ.* In its descent down the thorax the aorta is in contact with the left surface of the bodies of the dorsal vertebræ. At the lower part of the thorax, it inclines towards the middle line of the vertebræ in order to reach the hiatus aorticus of the diaphragm, through which it penetrates to the abdomen. Here it descends in front of the lumbar vertebræ, somewhat on their left side, ceasing at the intervertebral space between the fourth and fifth vertebræ by division into two large trunks, the primitive iliacs, one for each lower extremity and the corresponding side of the pelvis. In the course of the aorta from the heart to the loins, it first gives off the branches which supply the heart, then those for the head and superior extremities, then those for the sides of the thorax, and afterwards in the abdomen it detaches the trunks which supply the viscera and sides of the abdomen.

From the arch of the aorta there arise five arteries: the right and left coronary, the innominata, the left carotid, and the left subclavian. Exceptions to this arrangement not unfrequently occur, as in addition to the two coronary there are sometimes but two arteries, sometimes six.

CORONARY ARTERIES. The right and left coronary arteries are the nutrient vessels of the heart. They arise above two of the sigmoid valves, and communicate freely with each other by their ramifications,

The arteria innominata, about an inch and a half in length, arises from the upper part of the arch, at the junction between the ascending and horizontal portion; it ascends obliquely to the right side in front of the trachea and of the right pleura, and opposite to the sternal end of the clavicle divides into the right subclavian and right carotid arteries.

We thus have two pairs of arteries to consider for the head and superior extremities, two of them, the left common carotid and the left subclavian, arising immediately from the arch of the aorta; while the right subclavian and carotid are constituted by the bifurcation of the arteria innominata, about an inch from the aortic arch.

B. The Cartoid Arteries.

The right arises from the innominata, the left from the arch of the aorta; they ascend obliquely outwards as far as the os hyoides, where they divide into an *external* and an *internal.*

1. The External Carotid Artery ascends obliquely backwards to the fore part of the meatus auditorius covered by the skin, platysma, and fascia, as also by the digastric and stylo-hyoid muscles, the parotid gland, and portia dura nerve. It gives off ten arteries in three sets: anteriorly, the *superior thyroid*, *lingual*, and *labial;* posteriorly, the *muscular*, *auricular*, and *occipital;* superiorly, the *pharyngeal*, *transverse*, *facial*, *temporal*, and *internal maxillary.*

The superior thyroid arises opposite to the cornu of the thyroid cartilage, and descending obliquely forwards beneath the sterno-thyroid and omo-hyoid muscles, sends off the following branches: 1, the *superficial*, distributed to the integument and to the superficial muscles; 2, the *laryngeal*, to the muscles and mucous membranes of the larynx; 3, *hyoidean*, to the lower border of the os hyoides and adjacent muscles; 4, *superior thyroid*, to the thyroid gland.

The lingual artery arises immediately above the preceding; it ascends tortuously forwards and inwards, above the os hyoides to the base of the tongue, between the hyo and genio-hyoglossi muscles, and running horizontally forwards towards the tip of the tongue, gives off the following branches: 1, *hyoidean;* 2, *dorsalis linguæ*, which ascends to the dorsum of the tongue and is lost on the mucous membrane near its base, also on the velum and fauces; 3, *sublingual*, to the sublingual gland, mylo-hyoid muscle, and mucous membrane of the mouth; 4, *ranine*, the trunk continued along the lingualis muscle to the tip of the tongue.

The labial or external maxillary artery arises opposite the os hyoides, ascends behind the digastricus, and between the submaxillary gland and the base of the jaw, and turning around the latter rises towards the sides of the nose. In the neck it gives off: 1, the *inferior palatine* to the velum; 2, *glandular*, to the submaxillary and adjoining lymphatic glands; 3, *submental*, to the chin and surrounding muscles. On the face it gives off: 4, *inferior labial*, to the muscles and integuments between the lip and chin; 5, *inferior* and *superior coronary*, which run along the borders of the lips; 6, *lateralis nasi*, to the side of the nose; 7, *angularis*, which communicates with the ophthalmic.

The muscular artery descends obliquely backwards and divides into several branches, which are principally distributed to the sterno-mastoid and to the surrounding cellular tissue and glands.

The occipital artery arises opposite the labial, ascends obliquely back-

wards behind the digastric, then curves horizontally backwards between the mastoid process and the atlas, and near the mesial line it ascends on the occiput. It gives off several muscular branches, some to the mastoid and trapezius muscles, several to the deep muscles on the sides and back of the neck; and in the occiput it divides into tortuous branches which ascend in different directions in the scalp, and inosculate with the different arteries in that region.

The posterior auricular artery arises above, often in common with the occipital; it ascends behind the parotid and between the meatus auditorius and the mastoid process; it divides into several branches which are lost in the integument of the ear and in the scalp; one branch, named the *stylo-mastoid*, enters the foramen of the same name.

The inferior or ascending pharyngeal artery arises near the division of the common carotid, ascends vertically to the base of the skull, and sends off several pharyngeal and palatine branches, ending in a small branch which passes through the foramen lacerum posterius, and supplies the dura mater at the base of the cranium.

The transverse artery of the face arises from the carotid in the parotid gland, and is distributed to the muscles and integument of the face, and joins the branches of the facial artery.

The temporal artery is one of the two terminal branches of the external carotid; ascending over the root of the zygoma, about an inch and a half above the zygomatic arch, it divides into an anterior and posterior branch. The *anterior temporal* is distributed over the front of the temple and arch of the skull, and anastomoses with its fellow of the opposite side, and with the supra-orbital and frontal artery. The *posterior temporal* curves upwards and backwards, and inosculates with the posterior of the opposite side, and with the posterior auricular and occipital artery.

The internal maxillary artery ascends obliquely forwards behind the neck of the maxilla between the pterygoid muscles, and gives off the following branches: 1, the *middle artery of the dura mater*, which, passing through the foramen spinale of the sphenoid bone, divides into two branches which supply the bones of the cranium and the dura mater; 2, the *inferior dental:* this passes into the dental foramen and distributes minute arteries to the roots of the teeth. Between the pterygoid muscles it sends off, 3, the *deep temporal* branches to the temporal muscle; 4, *masseteric;* 5, *pterygoid;* 6, *buccal*, to the cheek; 7, *superior dental*, to the alveoli and gums; 8, *infra-orbital*, to the muscles of the face; 9, *nasal*, to the mucous membrane on the spongy bones and the septum; 10, the *superior palatine*, to the muscles and mucous membrane of the velum, and to the hard palate; 11, the *vidian*, a small branch which passes backwards. These terminating branches of the internal maxillary are entangled with the divisions of the superior maxillary.

Pl. 135, *fig.* 1[1], heart; [2], left, [3], right coronary artery; [4], pulmonary artery cut off; [5], arcus aortæ; [6], arteria innominata; [7], right common carotid; [8], left subclavian; [9], division of the innominata into the right carotid and subclavian; [10], division of the common carotid into outer and

inner; [11], superior thyroid; [12], lingual; [13], external maxillary; [14], inferior or ascending palatine; [15], submental; [16], inferior, and [17], superior coronary arteries of the lips; [18], nasal branch of the angularis; [19], occipital; [20], posterior auricular; [21], ascending pharyngeal; [22], division of the external carotid into two terminal branches; [23], transverse facial; [24], middle temporal; [26], anterior auricular. *Fig.* 2, the lingual artery; part of the lower jaw removed: [1], os hyoides; [2], hyo-glossus muscle cut away; [3], stylo-glossus muscle; [4], genio-glossus muscle; [5], external carotid; [6], lingual artery; [7], dorsalis linguæ; [8], sublingual; [9], ranine. *Fig.* 3, internal maxillary artery in part; the side of the top of the cranium is supposed to be removed, the ascending ramus of the lower jaw to be sawed off, and the body of the bone deprived of its outer table: [1], external carotid; [2], occipital artery; [3], posterior auricular; [4], superficial temporal; [5], middle temporal; [6], root of the internal maxillary; [6'], middle artery of the dura mater; [6''],[6''], anterior artery of the dura mater; [6'''],[6'''], posterior artery of the dura mater; [7], inferior dental; [7'], its course on the jaw; [8], branches for the pterygoid muscles; [9], for the masseter; [10], for the buccinator; [11], coronary artery of the upper lip; [12], superior dental; [13], infra-orbital at its entrance into, and [13'], at its exit from the infra-orbital canal; [14, 14], deep temporal arteries; [15], entrance of the main trunk into the infra-orbitar fissure. *Fig.* 4, internal maxillary within the fissure: [1], main trunk; [2], infra-orbitar artery; [3], superior palatine; [4], vidian.

2. THE INTERNAL CAROTID ARTERY ascends along the vertebral column and the side of the pharynx from the common carotid, posterior and external to the external carotid, behind the digastric and styloid muscles, internal to the jugular vein, and anterior to the vagus and sympathetic nerves, to the foramen caroticum in the petrous bone. It then bends tortuously forwards, upwards, and inwards through the carotid canal, enters the cavernous sinus, and passing the anterior clinoid process it divides opposite to the internal extremity of the fissure of Sylvius into its three terminating branches, viz. *posterior communicans*, *anterior cerebri*, and *media cerebri*. In the neck and in the carotid canal it sends off small and unimportant branches; one named tympanic, is distributed to the tympanum through a small hole in the carotid canal. The first branch of any importance is:

The Ophthalmic Artery. This arises close to the anterior clinoid process, and passes through the optic foramen below and external to the optic nerve: in the orbit, it passes round the nerve to the inner side of the cavity and terminates in the inner canthus. While on the outer side of the optic nerve it sends off: 1, *centralis retinæ*, distributed to the interior of the eye; 2, the *lachrymal*, which passes along the external rectus muscle and supplies the lachrymal gland and the palpebræ. While above the optic nerve it gives off: 3, the *supra-orbital*, which passes forwards along the levator palpebræ, and through the superciliary notch, supplying the muscles and integuments of the eyebrow and the scalp; 4, the *posterior ciliary*, ten or twelve in number and very small, becoming distributed to the choroid coat of the eye; 5, the long *ciliary* one on each side, passing horizontally forwards as

far as the ciliary circle, where they subdivide; 6, *muscular arteries* to the different muscles in the orbit; 7, *ethmoidal*, to the mucous membrane in the ethmoidal cells; 8, *superior* and *inferior palpebral* to the palpebræ, caruncula, conjunctiva, and lachrymal sac; 9, *nasal*, to the side of the nose; 10, *frontal*, to the eyebrow and forehead.

The posterior communicans arises from the carotid opposite to the ophthalmic, passes backwards and inwards, and joins the posterior cerebral circle.

The anterior cerebri, or *arteria callosa*, passes forwards and inwards above the optic nerve, anastomosing with the opposite by a short transverse branch, the *anterior communicans*, and ultimately terminates by dividing into branches for the corresponding hemisphere of the cerebrum.

The media cerebri, or middle cerebral artery, passes outwards in the fissure of Sylvius, and divides into two tortuous branches which supply the anterior and middle lobes of the cerebrum, sinking deep in the sulci between the convolutions in the island of Reil.

Pl. 135, *fig.* 5, distribution of the ophthalmic artery: [1], superior dental; [2], inferior dental; [3], internal carotid; [4], ophthalmic artery; [5], muscular branches; [6], lachrymal; [7], supra-orbital; [8], frontal artery; [9], a short or posterior ciliary; [10], a long ciliary; [11, 11], ethmoidal; [12], frontal branch. *Fig.* 6, some of the deep branches of the ophthalmic, the eyeball removed: [1], ophthalmic; [2], artery of the lachrymal sac; [3], superior, and [4], inferior palpebræ. *Fig.* 7, cerebral arteries: [1], anterior; [2], middle lobe of the cerebrum; [3], fissure of Sylvius; [4], pons varolii; [5], cerebellum; [6], medulla oblongata; [7], section of the trunk of the internal carotid; [8], posterior communicans; [8'], choroid artery; [10], artery of the corpus callosum; [11], anterior communicans.

C. The Subclavian Arteries and their continuations.

The great arterial trunks, of which the subclavian constitute the initial portion, have different names in different parts of their course, the series consisting of the subclavian proper, the axillary, the brachial, and the radial and ulnar.

1. The Subclavian Arteries Proper. The right and left subclavian arteries differ in diameter, length, situation, and relation. The right, as arising from the innominata, is shorter than the left, which springs from the arch of the aorta. The course of each may be divided into three stages: the first extends from the origin to the tracheal edge of the scalenus anticus; the middle stage is the transit of the artery between the scaleni muscles; the third stage extends from those muscles beneath the clavicle to the lower border of the first rib, below which the continued trunk receives the name of axillary artery. In the middle and last stages the right and left arteries are similarly circumstanced in all respects; the first stage is much longer on the left than on the right side.

The right subclavian, in its first stage, passes outwards and a little upwards, having anterior to it the internal jugular and subclavian veins, the sterno-mastoid, hyoid, and thyroid muscles. The left subclavian, from

its origin to the scalenus, is nearly vertical, and has anterior to it the sterno-mastoid, hyoid and thyroid muscles, the clavicle and first rib, the left vena innominata, left carotid artery, the left lung and pleura, &c.

The subclavian artery, in the middle stage of its course, on each side of the neck is covered by the sterno-mastoid and anterior scalenus muscle, and lies on the pleura and middle scalenus: the subclavian vein is inferior and anterior.

In the third stage it inclines downwards and outwards, and is covered only by the skin, platysma myoides, fascia, and cellular tissue; it rests on the middle scalenus and the first rib. The vein is inferior and anterior, concealed by the clavicle. The subclavian arteries in their course send off the following branches: vertebral, thyroid axis, internal mammary, superior intercostal, and deep cervical.

The *vertebral artery* arises from the upper and back part of the subclavian, and, ascending, enters the foramen in the transverse process of the fifth or sixth cervical vertebra, continuing through the corresponding cervical foramina as far as the second vertebra. Bending backwards in an exceedingly tortuous manner, it passes through the foramen in the transverse process of the atlas, and alternately piercing the dura mater, advances within the cranium through the foramen magnum, and unites with the opposite at the lower edge of the pons varolii to form the basilar artery. In this course it gives off small branches to the spinal nerves, and to the intervertebral muscles; at the foramen magnum it gives off, first and second, the *posterior* and *inferior spinal arteries*, which descend all along the spinal cord; third, the *inferior cerebral artery*, which runs tortuously around the medulla oblongata, sending off numerous branches to the inferior surface of the cerebellum.

The basilar artery is formed by the confluence of the two vertebral; it ascends in the median groove on the pons varolii, and at the upper edge of that body divides into four branches, two for each side: first, the *superior cerebellar artery*, passing backwards to the upper surface of each hemisphere of the cerebellum, in which it spreads its branches; second, the *posterior cerebral artery*, which receives the posterior branch of the internal carotid, bends backwards and outwards, and spreads its ramifications on the posterior lobe of the cerebral hemisphere. The communication between these posterior cerebral arteries and the posterior branches of the internal carotids, completes that remarkable inosculation known as the *circle of Willis;* this is formed anteriorly by the two cerebral arteries, with their cross uniting branch; laterally by each internal carotid, and its posterior communicating branch; and posteriorly by the trunk of the basilar, and the roots of the posterior cerebral arteries.

The thyroid axis arises from the upper part of the subclavian close to the scalenus muscle and phrenic nerve; it immediately divides into the four following branches: 1. The *inferior thyroid*, distributed to the thyroid gland, sending branches also to the trachea, œsophagus, &c.; 2. The *ascending cervical*, distributed to the anterior scalenus, longus colli, and rectus capitis anticus major muscles; 3. *Supra-scapular*, which supplies the supra-spinatus

and trapezius, as also the infra-spinatus and teres minor; 4. *Transversalis colli*, which ascending beneath the trapezius, divides into the *cervicalis superficialis*, going to the superficial muscles of the side and back part of the neck, and the *posterior scapular artery.*

The internal mammary artery arises opposite the thyroid axis; it descends obliquely forwards, between the cartilages of the ribs and the pleura, as far as the ensiform cartilages; sending off branches to various parts of the thorax, it terminates in the diaphragm and the abdominal muscles.

The superior intercostal artery arises between the scaleni, descends behind the pleura, in front of the neck of the first and second ribs, and supplies the two first pairs of intercostal muscles.

The cervicalis profunda lies opposite to the last, ascends backwards and outwards between the transverse processes of the sixth and seventh cervical vertebræ, and ascending on the back of the neck, supplies the complexus and other deep muscles in that region, and inosculates with the descending branches of the occipital artery.

Pl. 135, *fig.* 7, arteries of the brain: [12], vertebral artery; [13], posterior inferior cerebellar artery; [14], basilar artery; [15], anterior inferior cerebellar artery; [16], superior cerebellar artery; [17], deep cerebral artery. *Fig.* 8 [1], portion of the subclavian; [2], common trunk of the vertebral and deep cervical arteries; [3], course of the vertebral artery through the transverse processes of the vertebræ; [4], its first curvature; [5], the second curvature or bend; [6], its course within the cranium; [7], basilar artery, with its ramifications; [8], deep cervical; [9, 10], interosculations between this and the vertebral; [11], upper end of the transversalis. *Fig.* 1 [25], inferior thyroid; [26], vertebral; [27], entrance into the vertebral canal; [28], superior intercostal; [29], transversalis colli; [30], ascending cervical; [31], internal mammary; [32], small branches for the anterior mediastinum.

2. Axillary Artery. This artery descends from the lower edge of the first rib obliquely outwards, to the tendon of the latissimus dorsi muscle; it is covered by the integuments, and at first by the external border of the pectoralis major, still lower down by the tendon only of this muscle; it passes over the first intercostal, serratus magnus, subscapular, and tendons of the latissimus dorsi and teres major. The axillary vein descends along its inner and anterior parts, and the brachial plexus lies posterior and external to it. It sends off the following arteries: thoracica acromialis, superior and long thoracic, the subscapular, the posterior and anterior circumflex.

The acromio-thoracic artery arises from the front of the axillary below the subclavian muscles, above the pectoralis minor, and opposite the fissure between the pectoralis major and deltoid muscles; it divides into several branches, some of which pass to the pectoral muscles, others to the acromion process, deltoid muscle, and integuments of the shoulder and arm. One long brnnch accompanies the cephalic vein.

The superior thoracic arises a little below the preceding, sometimes in common with it; it passes forwards and inwards, and divides into branches

which supply the cellular membrane and glands in the axilla, the pectoral muscles, the breast and integuments.

The long thoracic artery arises below the lesser pectoral, and, passing obliquely forwards, terminates in the intercostal muscles and integuments.

The subscapular artery arises opposite to and descends along the lower edge of the subscapular muscle, and soon divides into an anterior and a posterior branch; the former supplies the subscapular, serratus magnus, and latissimus dorsi; the latter goes to the infra-spinatus and teres minor muscles.

The posterior circumflex artery arises below the last, and passes out of the axilla to the deltoid muscle.

The anterior circumflex artery is smaller than the preceding, and arises either from it or from the axillary. It sends branches to the deltoid, coraco-brachialis, and biceps; one long branch likewise goes to the synovial membrane of the shoulder joint.

The Brachial Artery descends obliquely outwards to the bend of the elbow, where it divides into the radial and ulnar arteries. It lies on the inner side of the coraco-brachialis and biceps. It is accompanied by a vein on either side, also by the median nerve. In addition to several muscular branches, it sends off the superior and inferior profunda and the anastomotica.

The superior profunda arises below the teres major, and passes downwards between the heads of the triceps and in the musculo-spiral groove of the humerus. It divides into two large branches; one descends in the triceps to the olecranon, the other accompanies the radial nerve to the outer condyle, and communicates with the radial recurrent artery.

The inferior profunda arises opposite to the tendon of the coraco-brachialis, descends on the surface of the triceps, along with the ulnar nerve, to the inner condyle, and communicates with the ulnar recurrent.

Pl. 134, *fig.* 1, arteries of the axilla and arm: [1], scalenus anticus muscle, behind which lies the axillary artery; [2], the pectoral, and [3], the acromial branch of the thoracico-acromialis; [3], superior thoracic; [4], long thoracic; [5], dorsal branch of the subscapular; [6], subscapular; [7, 8], anterior circumflex; [9], posterior circumflex; [10], brachial artery; [11], profunda; [12], accessory ulnar; [13], radial; [14], recurrent branch of do.; [15], ulnar; [16], anterior; [17], posterior recurrent branch; [18], interosseal artery.

3. The Ulnar Artery is larger than the radial, the other branch of the main trunk of the brachial. It descends along the ulnar side of the forearm to the palm of the hand, covered superiorly by the superficial flexors and pronators, and by the median nerve; inferiorly by the skin and fascia. It passes over the brachialis anticus, flexor profundus, pronator quadratus, the annular ligament of the carpus, and the flexor tendons in the palm of the hand. It is accompanied by two veins and by the ulnar nerve, the latter descending along its ulnar side.

It gives off: 1, the *anterior ulnar recurrent*, which ascends in front of the inner condyle on the brachialis anticus, and inosculates with the

anastomotica; 2, the *posterior ulnar recurrent*, which ascends behind the inner condyle, and anastomoses with the anastomotica and inferior profunda; 3, the *interosseal artery*, which passes backwards and divides into an anterior and a posterior branch, the former going to the carpal bones and to the sheaths of the extensor tendons, the latter to the extensor muscles; 4, *muscular branches* to the two layers of flexor muscles and to the skin; 5, *dorsalis carpi ulnaris*, to the back part of the wrist and hand; 6, *superficial palmar*, which forms the palmar arch, bending across the palm of the hand to inosculate with branches of the radial artery; 7, *palmaris profundus*, which joins the deep palmar branch of the radial artery, thus completing the deep palmar arch.

4. THE RADIAL ARTERY continues in the direction of the brachial artery, passing along the radial side of the forearm to the wrist; it then turns round the external lateral ligament of this joint, and passes forwards into the palm of the hand, terminating in three branches. It is accompanied by two veins, and the radial nerve is at its external side in the middle of the forearm. It passes over the biceps supinator brevis, pronator teres, flexor digitorum sublimis, flexor pollicis, and pronator quadratus.

It gives off: 1, the *radial recurrent* to the supinators and extensors, inosculating with the superior profunda; 2, *muscular branches*, to the flexors and supinators; 3, *superficialis volæ*, to the small muscles of the thumb, inosculating with the ulnar artery, forming the superficial palmar arch; 4, *dorsalis carpi radialis*; 5, *dorsalis pollicis*; 6, *radialis indicis*; 7, *magna pollicis*, along the first metacarpal bone, and dividing into two branches; 8, *palmaris profunda*, which, passing across the metacarpal bones, joins the deep branch of the ulnar, and thus forms the deep palmar arch, from which branches proceed to the interosseal muscles, and to the bones and ligaments of the metacarpus.

Pl. 134, *fig.* 2, arteries of the forearm and of the palm of the hand: [1], ulnar artery; [2], anterior interosseal; [3], posterior interosseal; [4], superficial palmar; [5], metacarpal branch; [6,7], digital branches; [8], radial artery; [9], its palmar branch; [10], deep palmar arch; [11], branch to the back of the hand; [12], an anterior branch. *Fig.* 6, arteries of the lower part of the forearm and the back of the hand: [1], branches of the external interosseal; [2], dorsal branch of the radial; [3], anastomoses on the back of the hand; [4], artery of the thumb; [5], third metacarpal branch.

D. Thoracic Aorta.

The thoracic aorta descends obliquely forwards from the termination of the arch to the diaphragm. It is inclosed in the posterior mediastinum; the root of the left lung above, the heart and pericardium in the middle, and the œsophagus with the vagal nerves below, are anterior to it. The vertebral column is behind. It gives off the bronchial, œsophageal, and intercostal arteries.

The *bronchial arteries* are two or three in number. They arise from the forepart of the aorta, below the arch. They pass to either side, enter the back part of the root of each lung, and are lost in the cellular tissue of these

organs. These arteries sometimes rise from the intercostal, and are very irregular in number and size.

The *œsophageal arteries* are also irregular, generally three or four in number. They arise from different parts of the aorta, and send branches to the mediastinum and œsophagus. On the latter, some ascend, some descend. The former inosculate with the cervical arteries, the latter with the abdominal.

The *intercostal arteries* are usually ten on the left, and nine on the right. They arise from the back part of the aorta, pass obliquely outwards behind the pleura, and enter the intercostal spaces; run along the lower edge of each rib between the layers of muscles, and, about the middle of the chest, divide into an inferior and a superior branch. They both supply the intercostal muscles, and inosculate with the internal mammary and with the thoracic arteries. Each intercostal artery, before entering the intercostal space, sends a large dorsal branch backwards to the muscles on the posterior part of the trunk.

Pl. 135, *fig.* 9, arch of the aorta, with the thoracic artery: [1], trachea; [2 3], branch; [4], œsophagus; [5], arch of the aorta; [6], innominata; [7], left common carotid; [8], left subclavian; [9], first intercostal; [10], thoracic aorta; [11,12], œsophageal arteries; [13 14], posterior bronchial; [15], an intercostal; [16], its anterior or intercostal branch; [17], its dorsal branch; [18], a branch to the medulla spinalis. *Fig.* 10, arteries of the spinal marrow, the anterior wall of the vertebral canal removed: [1], spinal marrow inclosed in its sheath; [2], an intercostal artery; [3], a spinal artery entering the intervetebral foramen and ramifying over the spinal marrow and its sheaths.

E. Abdominal Aorta.

The abdominal aorta commences below the tendinous arch, between the crura of the diaphragm in the median line, descends with a slight obliquity to the left, and divides at the lower margin of the fourth lumbar vertebra into the two iliac arteries. The middle sacral may also be considered as one of its terminal branches. It sends off the following branches: the phrenic, cœliac axis, superior mesenteric, inferior mesenteric, renal, supra-renal, spermatic, lumbar, and middle sacral.

1. The Phrenic Arteries arise in common or near each other, from the fore part of the aorta. They both send branches to the supra-renal capsules and to the crura of the diaphragm. The *right* ascends behind the vena cava, the *left* behind the œsophagus. On the diaphragm each divides into an external and an internal branch. The former passes towards the circumference of the muscle, and inosculates with the internal mammary and the inferior intercostals; the latter encircles the central tendon.

2. The Cœliac Axis arises from the fore part of the aorta opposite to the last dorsal vertebra; it soon divides into three branches.

a. The gastric artery. This sends branches to the cardiac orifice, to the œsophagus, and to the anterior and posterior surfaces of the stomach.

b. The hepatic artery. This divides ultimately into the right and left hepatic arteries. Previous to this division it gives off the *superior pyloric*

to the upper surface of the pylorus, and the *gastro-duodenalis*, which in turn yields *inferior pyloric branches*, the *pancreatico-duodenalis*, and the *gastro-epiploica dextra;* the first to the lower part of the pylorus, the second to the duodenum and pancreas, and the third to the great omentum and stomach. The *right* and *left hepatic* arteries then separate and plunge into the substance of the liver, accompanied by branches of the vena porta; the right hepatic is the larger, and before entering the gland gives off the *cystic artery* to the gall bladder.

c. *The splenic artery.* This is the longest branch of the cœliac axis; it passes backwards and to the left side along the upper edge of the pancreas, to which it sends several branches. Near the spleen it gives off the *gastro-epiploica sinistra.* It next sends off the *vasa brevia*, small branches which go to the great end of the stomach. The splenic artery then divides into several branches, which enter into the spleen.

Pl. 134, *fig.* 4, the abdominal aorta: [1], diaphragm; [2], kidney; [2'], supra-renal capsule; [3], aorta; [4, 5, 6], visceral arteries cut off; [7], supa-renal artery; [8], renal artery; [9], internal spermatic; [10], a lumbar artery; [11], phrenic artery. *Fig.* 3, cœliac artery: [1], liver; [2], gall bladder; [3], round ligament of the liver, formerly the umbilical vein; [4], stomach; [5], duodenum; [6], the spleen; [7], pancreas; [8], trunk of the cœliac artery; [9, 11], gastric artery; [10], hepatic artery; [12], gastro-epiploica dextra; [13], cystic artery; [14], splenic; [15], outline of the course of the splenic artery behind the stomach; [16], gastro-epiploica sinistra; [17], vasa brevia.

3. Superior Mesenteric Artery. This arises below the cœliac; descends obliquely forwards and to the left behind the pancreas and over the duodenum; it then passes between the layers of the mesentery and takes an arched course towards the right iliac fossa: from its concave side arise three branches, the *ileo-colic*, the *right colic*, and the *middle colic.* These branches proceed between the laminæ of the mesocolon to the large intestine; each dividing into two branches which unite with those on either side and form arches, from whose convexities other subdividing branches again arise and unite as before. These divisions and subsequent inosculations occur several times before reaching the intestine, near which each branch divides into two, which proceed in a direct course, one on the anterior, the other on the posterior surface of the intestine, and are distributed principally to the submucous tissue.

Pl. 134, *fig.* 4[5], origin of the superior mesenteric.

Pl. 135, *fig.* 11, distribution of the superior mesenteric: [1], folds of the small intestines: [2], cœcum; [3], its vermiform appendage; [4], ascending colon; [5], transverse colon; [6], superior mesenteric artery with branches going off to the small intestines, forming numerous inosculations; [7], right colic artery; [8], middle colic.

4. The Inferior Mesenteric Artery arises about two inches below the preceding; it descends towards the left iliac fossa and divides into three branches, the left colic, sigmoid, and superior hæmorrhoidal.

The left colic artery ascends in the left mesocolon, anastomoses with the middle colic branch of the superior mesenteric, and supplies the left part

of the colon. The *sigmoid artery* is distributed to the sigmoid flexure of the colon. The *superior hæmorrhoidal* descends along the back part of the rectum, supplies the coats of this intestine, and inosculates with the middle and inferior hæmorrhoidal arteries.

5. THE RENAL ARTERIES arise from the sides of the aorta, between the superior and inferior mesenteric arteries; both pass behind their corresponding vein and divide near the kidney into five or six branches, which ramify through the substance of this gland.

6. THE CAPSULAR ARTERIES are three in number; they arise either from the renal arteries or from the aorta, and supply the renal capsules.

7. THE SPERMATIC ARTERIES arise from the fore part of the aorta; in the male they accompany the vas deferens of each side through the spermatic canal, and supply the testis and epididymis; in the female they pass to the ovaries, and also send branches to the Fallopian tubes and to the sides of the uterus.

8. THE LUMBAR ARTERIES are four or five pairs. They are analogous to the intercostal arteries, and arise from the back part of the aorta, to be distributed mainly to the muscles of the back and loins.

9. THE MIDDLE SACRAL ARTERY arises from the back part of the aorta, a little above its bifurcation; descending nearly in a median line, it sends branches to the sacrum and communicates with the lateral sacral arteries. This is essentially the continuation of the aorta, as may be clearly seen in animals having weak posterior extremities and a highly developed tail.

Pl. 135, *fig.* 12 [1], large intestines; [2], aorta; [3], superior mesenteric; [4], section of one of its branches to the small intestines; [5], right colic artery; [6], a vascular arch of the right colic; [7], boundary between large and small intestines; [8], inferior mesenteric; [9, 10, 11], left colic branch; [12, 13], superior hæmorrhoidal.

F. Iliac Arteries.

The right and left common iliac arteries arise and diverge from the bifurcation of the aorta, which usually occurs on a level with the lower margin of the fourth lumbar vertebra. The point of division, as well as its angle, is, however, variable; nevertheless in the female the angle of bifurcation is always greater than in the male. These vessels descend obliquely outwards as far as the ilio-sacral symphysis, opposite to which, and resting on the psoas magnus, each divides into the external and internal iliac arteries; their length varies from one and a half to two inches.

1. THE INTERNAL ILIAC OR HYPOGASTRIC ARTERY passes downwards in front of the ilio-sacral articulation, describing a curve concave forwards, and reaches the superior part of the sacro-sciatic notch, when it usually divides into a number of branches. From its termination a ligamentous cord (the obliterated umbilical artery of the fœtus) extends to the back and sides of the bladder, and from this to the posterior surface of the recti muscles as far as the umbilicus. It gives off the following branches: ilio-lumbar, lateral sacral, hæmorrhoidal, vesical, uterine, and vaginal; the glutæal, sciatic, obturator, and pudic.

1. The *ilio-lumbar.* This arises from the back part of the internal iliac and passes into the substance of the iliacus internus, in which it divides into ascending and descending branches. 2. The *lateral sacral* descends obliquely in front of the sacral holes, and sends branches to the spinal nerves and to the pyriform muscle. 2. The *hæmorrhoidal.* These are two or three branches of uncertain origin, which pass to the sides of the rectum and communicate with the superior and inferior hæmorrhoidal arteries. 4. The *vesical arteries;* these arise from the iliac or some of its branches, and ramify on the coats of the bladder. 5. The *uterine* and *vaginal arteries,* arising from the internal iliac or from some of its branches. 6. The *glutæal artery* passes backwards and outwards from the pelvis by the upper part of the sciatic notch, and divides into several branches, supplying the glutæi. 7. The *obturator* passes out from the pelvis into the upper part of the thigh, and supplies the obturator and adductor muscles. 8. The *sciatic artery* escapes from the pelvis through the sciatic notch, and supplies the glutæus maximus, the hamstrings, and the adductor magnus. 9. The *internal pudic* leaves the pelvis and re-enters it again between the sciatic ligaments; ascending, it divides into two branches a little below the symphysis pubis. On re-entering the pelvis, it gives off: *a*, the *external hæmorrhoidal arteries* to the sides of the rectum and anus; *b*, the *perinæal artery* to the perinæum and scrotum; *c*, *transversalis perinæi; d*, *artery of the bulb* to the corpus spongiosum urethræ; *e*, and *f*, *artery of the corpus cavernosum* and *dorsalis penis.*

Pl. 134, *fig.* 4 [12], middle sacral artery; [13], division of the abdominal aorta into the two iliac arteries; [14], division of the iliac arteries into the external and internal iliac arteries; [15], ilio-lumbar; [16], inferior epigastric.

Pl. 135, *fig.* 13 [1], end of the abdominal aorta; [2], middle sacral; [3], a lumbar artery; [4], common iliac artery; [5], femoral or external iliac artery; [6], circumflex ilii; [7], inferior epigastric; [8], umbilical artery; [9], obturator; [10], vesical; [11], ilio-lumbar; [12, 13], lateral sacral; [14], superior glutæal. *Fig.* 14, obturator artery, and its division into an anterior and a posterior branch in the upper part of the thigh.

2. The External Iliac Artery proceeds from the common iliac, downwards and outwards to Poupart's ligament, beneath which it passes, and then receives the name of femoral. Near the groin it gives off two branches: 1. *Circumflex ilii,* which, arising from its outer side, ascends obliquely outwards as far as the crest of the ilium, where it branches to go to the abdominal muscles, and to the iliacus internus and quadratus lumborum; 2. The *epigastric artery,* which arises from the fore part, a little above Poupart's ligament, and, first descending, ascends between the abdominal muscles and the peritonæum, ultimately reaching the rectus muscle, the umbilicus, and the internal mammary artery.

3. The Femoral Artery, the continuation of the external iliac, descends from the middle of the crural arch, along the anterior and internal part of the thigh. It sends off—

a. Some superficial branches, as the *inguinal*, to the inguinal glands; the

superficial pubic, to the pubes; the *superficial epigastric;* and the *external circumflex ilii*, to the skin about the crest of the ilium.

b. The profunda. This, the largest branch of the femoral, arises about two inches below the crural arch, from the outer and back part of the femoral artery, and descends behind it. At the back part of the thigh it terminates in two branches for the hamstring muscles, and in its course gives off the two circumflex, and the three perforating arteries. The *external circumflex* arises from the outer part of the profunda, and, passing transversely beneath the sartorius and rectus muscles, divides into three fasciculi of branches. The *internal circumflex* arises near the preceding, sometimes from the femoral itself, and passes to the back part of the thigh. The *first*, or *superior perforating artery*, passes backwards beneath the lesser trochanter to the adductor magnus and to the hamstring muscles. The *second*, or *middle perforating artery*, passes through the adductor magnus and brevis to the muscles on the back of the thigh. The *third*, or *inferior perforating artery*, descends behind the adductor longus to the hamstrings. On the back part of the thigh the profunda ends in two branches, of which one passes to the biceps, the other to the semi-membranosus.

c. After the origin of the profunda, the femoral gives off several small twigs, and near the opening in the triceps it gives off a third, the *anastomotica magna*, whiah descends in front of the adductor tendon to the knee, and sends several branches to the integuments, vastus externus, and to the patella.

4. The Poplitæal Artery descends from the inner side of the femur, outwards to the inferior and central part of the poplitæal space. Its branches are: 1. Several muscular branches to the hamstrings, and to the gastrocnemius; 2. *Superior articular*, which encircle the lower extremity of the femur, and communicate with the anastomotica; 3. *Azygos articular*, passing forwards through the posterior ligament of the joint to the synovial membrane, and the adipose substance in its cavity; 4. *Inferior articular arteries*, which encircle the lower part of the joint to its fore part, and inosculate with the preceding, and with the anterior tibial recurrent. At the lower part of the ham the poplitæal divides into the anterior and posterior tibial arteries.

5. The Anterior Tibial Artery perforates the interosseous space close to the head of the fibula, descends along the interosseous membrane, and over the lower part of the tibia, to the first interosseous space. It gives off: 1. The *recurrent* to the articulation of the knee; 2. *Muscular branches* to the muscles on the outer and anterior part of the leg; 3. *Malleolar branches* to the internal and external malleoli; 4 and 5. *Tarsal* and *metatarsal;* between the two first metatarsal bones it divides into, 6, the *anterior pollicis* to the integuments, and 7, *communicans* to the first interosseal muscles.

6. The Posterior Tibial Artery descends between the superficial and deep layer of muscles on the back of the leg, to the space between the heel and inner ankle, where it divides into the external and internal plantar arteries. It gives off: 1. Several muscular branches; 2. The *peronæal artery.* This arises about an inch below the poplitæal, and, descending to the ankle, divides into the *anterior* and *posterior peronæal branches.* The

former pierces the interosseous ligament, and inosculates with the external malleolar; the latter spreads its branches on the outer side of the heel and of the foot.

The internal plantar artery proceeds along the internal side of the sole, and inosculates with the adjacent vessels. The *external plantar*, much the larger, passes forward as far as the fifth metatarsal bone; it then crosses the metatarsus, and joins the anterior tibial, to form the plantar arch.

Pl. 135, *fig.* 15 [1], sartorius muscle, cut off; [2], hole in the tendon of the adductor magnus; [3], femoral artery; [4], superficial epigastric; [5], profunda artery; [5', 5'], perforating branches of the profunda; [6], internal, [7, 8], external circumflex arteries; [9, 10], superficial pudic; [11], poplitæal artery. *Fig.* 17 [1], anastomotica; [2], anterior tibial; [3], recurrent branch; [4], external, [5], internal malleolar; [6], tarsal vessels; [7], metatarsal vessels; [8] an artery of the toes. *Fig.* 16, plantar arteries: [1], posterior tibial artery; [2], internal, [3], external plantar arteries; [4], deep plantar arch; [5], a branch to the back of the foot. [6], a metatarsal artery; [7], its division into two branches; [8], union of two such branches; [9], division into the arteries of the toes; [10], union of two such divisions; [11], vascular plexus at the tip of the toes.

3. The Veins.

The veins commence in the capillary system, and are therefore continuous with the arteries: in some parts they appear to arise out of a cellular or spongy intermediate structure, although this may be nothing more than a venous plexus. From the origins the veins unite and form larger branches, which ultimately end in two great trunks. Both small and large veins are remarkable for their numerous anastomoses, and large veins are often seen to divide and unite again.

Veins are composed of the same number of coats as arteries, but the middle lamina is much thinner, therefore they collapse when empty or when divided. The external or cellular coat is similar to that of arteries; the middle or fibrous coat wants the external elastic lamina, but possesses the two other layers of contractile fibres, the external circular and the internal longitudinal; the third, or innermost, or serous coat is stronger, but similar to that of the arteries, being, indeed, continuous with it through the capillaries on the one hand, and the cavities of the heart on the other. The most striking peculiarity in this tissue is seen in the presence of numerous semilunar folds or valves; each of these is composed of a duplicature of the membrane, inclosing some fibrous cord. Their concave floating end is towards the heart, and therefore the blood in its course towards this organ meets no resistance from the valves, while they present serious obstacles to its reflux. These valves are sometimes in pairs, sometimes single; they are most numerous in the extremities and in the deep veins, and are generally found at points of confluence; they are absent in very small veins, and in the large trunks, as the cavæ, iliacs, internal jugular, and innominata; also in the cerebral veins, and in the whole of the portal system.

In the descriptive anatomy of the veins, we divide the whole into the deep and the superficial; the former are called "venæ comites," as they generally accompany the arteries. As the latter of course have much the same distribution as the arteries, the superficial veins will alone require especial attention.

All the venous blood of the body empties into the heart through the two venæ cavæ, excepting that of the heart itself, which is poured directly into the right auricle by the *coronary* or *cardiac vein.* We shall begin with the description of the branches of the superior vena cava, belonging to the head, neck, thorax, and superior extremities, although, owing to the great number of the veins and their incessant anastomoses, it will be impossible to classify them with the precision of which the arteries are generally capable.

A. Veins of the Head and Neck.

The veins of the head and neck are superficial and deep: the superficial veins of the head return the blood from the scalp; the deep veins are those of the brain and sinuses.

It may on the whole be said that the superficial veins return the blood circulated by the external carotid artery, while the deep veins bring back that of the internal carotid. Starting at the heart, we find the superior vena cava subdivided into two large veins, the right and left venæ innominatæ or brachio-cephalic veins. Each of these is formed by the union of the subclavian and internal jugular of each side, the subclavian subdividing into the external jugular and axillary veins. The superficial veins of the head converge and unite so as to form two trunks, the facial and the temporal; the former empties into the internal jugular vein, the latter into the external.

The Facial Vein lies obliquely along the sides of the face, extending from the inner margin of the orbit downwards and backwards to the anterior edge of the masseter muscle. Resting on the same plane with the facial artery, it maintains nearly the same relations. It commences at the side of the root of the nose by a vein formed by the conflux of branches from the forehead, eyebrow, and nose, and increases by receiving others at each step of its course.

The frontal vein commences on the roof of the skull by branches which pass obliquely downwards and forwards on the forehead, maintaining communication with the anterior branches of the temporal. By the successive union of different branches, a vein of some size is ultimately formed, which descends vertically, parallel with the corresponding vessel of the opposite side, with which it is connected by transverse branches. When descending from the forehead, it receives branches from the eyebrow, the nose, and the upper eyelid.

The *supra-orbital* vein runs transversely inwards in the direction of the eyebrow; its radicles are connected externally with those of the external palpebral and superficial temporal; in its course it receives branches from the contiguous muscles and integuments, and at the inner angle of the orbit it inclines downwards to form the frontal vein. The two by their junction

form the *angular vein*, which runs downwards and outwards by the inner margin of the orbit, resting against the side of the root of the nose. It receives the *nasal veins* from the side and ridge of the nose, and some small palpebral veins open into it from the opposite direction. When arrived on a level with the lower margin of the orbit, the angular vein terminates by becoming continuous with the facial vein.

The facial vein, thus started, increases by recurving branches from the lower eyelid, and from the ala of the nose and from its outer side, the *inferior palpebral vein.* Lower down it is joined by branches from the lip and cheeks, and uniting with a branch from the temporal vein, empties into the trunk of the internal jugular. Previously, however, it receives the *ranine vein*, from the tongue, the *submental vein*, and the *palatine vein.*

THE TEMPORAL VEIN is a vessel of considerable size, extending from the zygoma to the angle of the jaw, while its branches spread out on the sides of the head. The principal of these branches are, the *posterior temporal*, the *middle temporal*, and the *anterior temporal.* Sinking below the angle of the jaw, it divides into two branches, of which one joins the facial vein, and the other becomes continuous with the external jugular vein. Other branches opening into the temporal vein are, the *parotid*, the *articular*, the *auricular*, the *transversalis faciei*, and the *auricularis posterior.* A vein of considerable size, joining the temporal in the parotid gland, is:

The internal maxillary. This receives branches from the temporal fossa, from the pterygoid muscles, from the surface of the upper jaw, and from the lower through the dental foramen.

THE EXTERNAL JUGULAR VEIN commences on a level with the angle of the jaw by the union of two branches, one the communicating branch from the termination of the temporal vein, the other from the mastoid region. Descending vertically, it unites with the subclavian. The principal veins which open into it are, the *anterior jugular* from the fore part of the chin, and from the scapular region, the *supra-scapular* and the *posterior scapular.*

CEREBRAL VEINS. The venous system within the skull consists of veins properly so called, and sinuses or reservoirs. The former we shall not consider in this place. The sinuses of the cranial cavity may be divided into two sets, those placed in the prominent folds of the dura mater and those disposed at the base of the skull. The former all converge more or less to a common point, which corresponds to the internal occipital protuberance, and is called the *torcular herophili.* The sinuses are as follows: 1. The *superior longitudinal sinus*, extending from before, backwards in the upper part of the falx cerebri, and commencing at the crista galli. 2. *The inferior longitudinal sinus.* This very small sinus is placed in the inferior concave border of the falx, and opens into the straight sinus. 3. *The straight sinus*, a continuation in a measure of the last, runs backwards in the direction of the base of the falx cerebri. 4. *The lateral sinuses.* Their direction conforms to that of the groove on the interior of the occipital bone, and passing from the protuberance to the foramen lacerum posterius. 5. *The posterior occipital sinus*, which conducts from the posterior margin of the foramen magnum to the torcular.

The basal sinuses are, the *circular*, the *cavernous*, the *superior petrosal*, the *inferior petrosal*, and the *occipital*.

THE INTERNAL JUGULAR VEINS. The blood from the brain and cranial cavity is received by the internal jugular veins, which are continuous at their upper extremities with the lateral sinuses and terminate inferiorly in the venæ innominatæ. The junction of the internal jugular vein with the lateral sinus takes place in the broad part of the foramen lacerum. Passing down to a level with the os hyoides, it receives the common trunk of the facial and temporal veins, and then enlarges considerably. Previously to the junction with the facial vein, it receives the *lingual vein* from the tongue, the *pharyngeal* from the back and sides of the pharynx, the *superior thyroid* and the *occipital* from the back of the head.

THE VERTEBRAL VEINS commence among the deep muscles beneath the occiput, inosculate with the occipital vein, and enter the canal in the transverse processes between the foramen magnum and the atlas. Descending they receive various muscular branches, and empty into the subclavian vein nearly opposite to and behind the internal jugular.

INFERIOR THYROID OR TRACHEAL VEINS form a plexus in front of the trachea. They commence about the thyroid body, and open into the vena innominata or into the cava.

THE VENÆ INNOMINATÆ. These, as already remarked, unite to form the superior vena cava. The *left vena innominata* is about three inches long, and receiving the thoracic duct at its commencement, is joined in its course by the left vertebral, the inferior thyroid, internal mammary, superior phrenic, and mediastinal veins. The *right vena* is an inch in length, and descends almost perpendicularly. It receives at its commencement the right absorbent trunk, and in its course the right vertebral vein, and sometimes the right inferior thyroid and right mammary and mediastinal veins.

THE SUPERIOR VENA CAVA descends from the confluence of the venæ innominatæ almost vertically, enters the pericardium, and opens into the right auricle behind its appendix. The vena azygos joins it just before it enters the pericardium. It returns the blood from the supra-diaphragmatic part of the body, and communicates with the inferior vena cava through the vena azygos and the vertebral veins.

THE AZYGOS VEINS constitute important appendages to the venæ cavæ, maintaining numerous communications between their branches, securing the course of the circulation, notwithstanding any local impediment in any particular vessel. The *right* or *greater azygos* commences in the abdomen, and ascending through the aortic passage of the diaphragm, empties into the back part of the superior cava. It receives several branches, and drains the thorax.

Pl. 133, *fig.* 1, superficial veins of the head and neck: [1], pericardium displayed; [2], right auricle; [3], superior vena cava invested by the pericardium; [4], do. above the pericardium; [5], right subclavian; [6], root of the internal mammary vein; [7], left subsclavian vein; [8], internal jugular; [9], thyroid; [10], transverse cervical and scapular veins; [11], anterior facial vein;

[12], its union with the ophthalmic vein; [13], frontal vein; [14], occipital vein; [15], superficial temporal vein; [16], axillary vein; [17], the cephalic vein.

Pl. 136, *fig.* 1 [1], right auricle; [2], superior vena cava; [3], internal mammary; [4], a vein of the diaphragm; [5], right subclavian vein; [6], right internal jugular vein; [7], right external jugular; [8], left subclavian; [9], lower thyroid; [10], left mammary; [11], left internal jugular; [12], left external jugular. *Fig.* 7, sinuses of the falx cerebri: [1], superior longitudinal sinus; [2], inferior do.; [3], straight sinus; [4], great meningeal vein; [5], confluence of the sinuses. *Fig.* 8, sinuses at the base of the skull: [1], place of entrance of the superior longitudinal sinus into the torcular; [2], horizontal portion of the lateral sinus; [3], its descending portion; [4], mouth of the internal jugular; [5], superior petrosal sinus; [6], cavernous sinus; [7], transverse branch along the sella turcica to form the transverse sinus. *Fig.* 9, point of confluence of the sinuses or the torcular herophili, opened: [1], superior longitudinal sinus; [2], opening of the straight sinus; [3, 3], openings of the posterior occipital sinuses; [4, 4], openings of the lateral sinuses. *Fig.* 10, a parietal bone, with the outer table removed to show the diploic veins.

B. Veins of the Superior Extremities.

The veins of the upper extremities are superficial and deep. The principal superficial veins are the cephalic, basilic, and median. The superficial veins of the hand are principally on the dorsal aspect. On the back of the hand there is a venous arch or series of arches, which receive two freely anastomosing veins from each finger. From this arch branches ascend, two of which being larger and more regular, have received distinct names, cephalic and basilic.

The *cephalic vein* commences on the outer and back part of the carpus, ascends to the bend of the elbow, and continuing along the outer side of the biceps, turns forward towards the shoulder, and sinks deep between the pectoral and deltoid muscles to join the axillary vein.

The *basilic vein* commences from the dorsal arch near the lower end of the ulna. One branch from the little finger is termed *salvatella.* Ascending along the ulnar side of the forearm, it passes before the internal condyle, and continuing up the inner side of the arm, joins the axillary vein.

The *median vein* arises a little above the wrist, and ascends along the middle of the forearm to the bend of the elbow. It here divides into two branches; one (median basilic) joins the basilic vein, the other (median cephalic) joins the cephalic vein.

The deep veins accompanying the brachial artery and its branches in the arm and forearm, two with each inclosed in the same sheath. These end in the

Axillary Vein, which ascends in front of the artery, receives the thoracic veins, passes beneath the clavicle, and opposite the lower edge of the first rib is named

Subclavian Vein. This passes inwards, receiving several veins from the shoulder and sides of the neck, as also the jugular veins, and opposite

the sterno-clavicular articulation, unites with the internal jugular, as already described, to form the vena innominata.

Pl. 133, *figs.* 2 *a*, *b*, superficial veins of the arm on the inside; *fig.* 2 *a* [1], axillary vein; [2, 3], cephalic vein; [4], median vein passing into the cephalic; [5], basilic vein; [6], its dorsal branch; [7], anterior branch; [8], median vein passing into the basilic; [9], common trunk of the median vein. *Fig.* 3, plexus on the back of the hand and forearm: [1], cephalic vein; [2], its origin at the thumb; [3], basilic vein; [4], its origin at the little finger. *Fig.* 4, veins at the bend of the elbow, used in blood-letting: [1], opening in the brachial aponeurosis, showing the course of the brachial artery and vein, with the relative position of the median nerve; [2], cephalic vein; [3], a branch; [4], median vein passing into the cephalic; [5], basilic vein; [6], dorsal branch; [7], anterior branch; [8, 9], stem of the median vein.

Pl. 136, *fig.* 1 [13], stem of the intercostal veins of the left side; [14, 15], union of such veins; [16], hemiazygos vein; [17], inferior cava. *Fig.* 2, azygos and hemiazygos (lesser azygos) veins: [1], superior vena cava; [2], azygos vein; [3], upper intercostal vein of the left side; [4, 5], venous trunks uniting to form the hemiazygos; [6], branches uniting to form the azygos; [7], inferior cava; [8, 9, 10], intercostal veins uniting partly with the azygos, partly with the superior intercostals, and partly with the hemiazygos. *Fig.* 5, venous plexus on the anterior wall of the vertebral canal: [1], two longitudinal trunks; [2], transverse connecting branches; [3], branches passing through the intervertebral foramina, and communicating with the external plexus. *Fig.* 6, plexus on the posterior wall of the vertebral canal: [1], the two longitudinal trunks; [2], the transverse connecting branches; [3], intercostal veins uniting with the inner plexus

C. Veins of the Inferior Extremities.

The veins of the lower extremities are superficial and deep. The general course of these veins (commencing at the feet) is as follows: the superficial veins of the foot feed the external and internal saphena veins, which empty, the former into the poplitæal vein, the latter into the femoral, which is itself only a continuation of the poplitæal. The femoral, after it is joined by the profunda and saphena veins, becomes the external iliac, which unites with the internal iliac, to form the common iliac. Finally the common iliacs of the two sides unite to form the inferior or ascending vena cava.

The External Saphena Vein passes from the dorsum of the foot behind the external malleolus, and joins the poplitæal.

The Internal Saphena commences at the upper and inner part of the foot, and ascends in front of the inner ankle, along the inner side of the leg, and behind the internal condyle of the knee. Inclining to the internal and anterior part of the thigh, it ascends to within about two inches of Poupart's ligament, passing through the saphenic opening of the fascia lata to join the femoral vein. It receives numerous branches throughout its course.

The deep veins of the leg, accompanying the arteries, two with each, and terminating in the following:

Poplitæal Vein. This lies posterior to the artery, and receives the

posterior saphena vein, with numerous branches: ascending obliquely inwards, it passes through the opening in the tendon of the triceps to become the

FEMORAL VEIN, which is joined in the groin by the profunda and saphena veins to form the

EXTERNAL ILIAC VEIN. This extends from Poupart's ligament to the ilio-sacral symphysis, where it meets the internal iliac to form the common iliac. It also receives the trunk of the epigastric veins, and of the two circumflex ilii.

THE INTERNAL ILIAC VEIN accompanies the artery in its inner side; it is formed by the union of several veins corresponding to the branches of the internal iliac artery, viz. *obturator*, *pudic*, *sciatic*, *glutæal*, &c.

THE COMMON ILIAC VEINS are formed by the union of the two internal and external, opposite each ilio-sacral symphysis. Ascending, they meet at an acute angle, opposite the fourth intervertebral ligament to the right side of and a little below the division of the aorta. Their union constitutes the inferior or ascending vena cava.

THE INFERIOR VENA CAVA, thus constituted, ascends along the right side of the aorta, passes through the diaphragm, and opens into the lower and back part of the right auricle. It receives the *lumbar*, *spermatic*, *renal* or *emulgent*, *capsular* or *supra-renal*, *inferior phrenic*, and the *hepatic* veins. The inferior cava is larger than the superior; it returns the blood from all parts of the body below the diaphragm, collecting that of the portal system through the medium of the hepatic veins.

Pl. 136, *fig.* 1 [18], hepatic vein; [19], internal spermatic; [20], supra-renal; [21], renal veins; [22], connecting branch between the renal and common iliac veins; [23, 24], lumbar veins; [25], common iliac; [26], femoral; [27], hypogastric; [28, 29, 30], lateral and middle sacral veins.

Pl. 134, *fig.* 7 [1], internal saphena vein; [2], exterior epigastric; [3], an accessory, and [4], a principal branch of the internal saphena. *Fig.* 8 [1], course of the internal saphena on the inside of the leg; [2], its commencement on the back of the foot. *Fig.* 9, plexus on the back of the foot. *Fig.* 10 [1], external saphena; [2], internal do.

4. THE PORTAL SYSTEM.

The portal system constitutes a peculiar vascular arrangement in the liver for the purification of the blood and the secretion of the bile. The *portal vein*, or *vena porta*, although it arises in the abdomen as a vein, and serves the same office, yet terminates in the liver like an artery, and has a secreting function; it returns the blood from all the chylopoietic viscera, to be distributed through the liver, and in the latter organ it receives the venous blood from the termination of the hepatic artery. It is four or five inches long, and is formed by the confluence of the splenic and mesenteric veins behind the pancreas. Ascending obliquely, it receives branches from the pancreas, duodenum, stomach, and gall-bladder, and enters the left extremity

of the left fissure of the liver, there to divide into right and left branches, which in the liver become subdivided into smaller branches divisible into three orders: *vaginal*, *interlobular*, and *lobular*. The lobular branches constitute the ultimate ramifications, entering and forming a plexus in each lobule of the liver; they are then continued into the *intralobular* veins, which unite in the *sublobular*, these combining to form the hepatic trunks of the hepatic veins which pour their blood into the inferior vena cava. In the lobules, the venous blood is depurated by the secretion of the bile, which pours into the hepatic ducts. The object of the *hepatic artery* is probably nutritive, and not secreting as formerly supposed.

Pl. 133, *fig.* 5 [1], liver; [2], gall-bladder and duct; [3], hepatic artery; [4], inferior vena cava; [4',4'], head of the pancreas; [5,5], the two posterior sections of the duodenum; [6,6,6,6], folds of the small intestines; [7], cœcum and ascending colon; [8], descending colon and rectum; [9], spleen; [10], stomach turned back; [11,11], veins of the jejunum and ileum; [12], right vein of the ileum; [13], superior mesenteric vein; [14,14], splenic vein; [15], lesser mesenteric vein; [16], left plexal vein of the stomach; [17], left coronary vein of the stomach; [18,19], trunk of the vena porta; [20], umbilical vein.

5. The Lymphatics.

Absorption, so necessary to nutrition, is effected by means of minute vessels termed absorbents, and the small reddish bodies termed absorbent or conglobate lymphatic glands, through which the absorbents pass. The absorbents are divided into two classes, named lymphatics and lacteals. The lacteals are found only in the abdomen, and are so called from the milky appearance of the chyle which they absorb from the intestinal villi, and which is conveyed by their trunk, the thoracic duct, into the general circulation. The lymphatics are so named from the clear fluid or lymph they contain; they are distributed through all parts of the body, and their office is to absorb in every tissue all matters that have become effete or useless: these, being first reduced to a state of solution, are conveyed into the general circulation, either to be discharged from the system by some of the excretory organs, or to undergo certain changes fitting them again for the purposes of the animal economy. The lymphatics are arranged, like veins, into superficial and deep; the former accompany the subcutaneous veins, the latter the deep-seated vessels; they run very much parallel to each other, often bifurcate, and either soon reunite or join similar adjacent branches: as they approach any of the glands they converge, each divides into two, which inclose its extremity, and soon enter through its surfaces; these are the *vasa inferentia.* Within the gland they subdivide and inosculate so as to form an inextricable plexus; from this, branches again issue and leave the gland by the opposite end; these are the *vasa efferentia*, and are larger, but fewer, than the vasa inferentia. All absorbents pass through one gland at least, and some through more, before they empty into the venæ innominatæ. The structure of the absorbents is very similar to

but more delicate than that of veins; they have three coats, but the middle, as in the veins, is thin, and wants the elastic lamina.

The lymphatic or conglobate glands are very numerous both in the extremities and in the trunk; their size varies from that of a small currant to that of an almond; the largest are in the groins and in the roots of the lungs. Their form is round, or irregular and lobulated.

The Lymphatic Vessels of the Lower Extremities. These are superficial and deep. The superficial commence from the toes, rise along the dorsum of the foot, and pass up the leg in two divisions, which, however, frequently communicate: one, the internal group, passes in front of the inner ankle, and keeps parallel and close to the great saphena vein; these branches ascend to the groin, and pass through the inferior superficial gland into the external iliac gland. The external set of superficial lymphatics ascend behind the inner ankle, accompany the external saphena vein to the ham, pass through the glands there situated, and join the deep lymphatics of the limb.

The lymphatics of the trunk and viscera are very numerous and exceedingly complicated. The absorbents of the small intestines are either lymphatics or lacteals; the former arise in the subserous tissue, the latter in the submucous tissue and in the villi. The lacteals proceed at once from the intestine into the mesentery and its glands: they take up the chyle and pour it into the thoracic duct.

The thoracic duct, great or left, is the common recipient of the absorbents not only of the infra-diaphragmatic portion of the body, but also of those of the left side of the chest, head, neck, and left arm. It commences by the confluence of a variable number of branches, in a common reservoir or dilatation called *receptaculum chyli*, which is placed to the right and somewhat behind the aorta, and rising into the neck, arches forwards and downwards, opposite the seventh cervical vertebra, and empties into the angle between the left subclavian and jugular veins, protected by a pair of valves against regurgitation from these vessels.

The head, face, and neck are well supplied with lymphatics. Ten, however, occur in the cranium, and none have as yet been detected in the brain. In the upper extremity, the superficial lymphatics commence from the fingers and the back part of the hand, and accompany the subcutaneous veins. The deep lymphatics follow the individual blood-vessels, reach the axillary glands, and receive various branches. On the left side they accompany the subclavian vein and join the descending portion of the thoracic duct. On the right side, the axillary or subclavian lymphatics, joined by the right cervical, form a short trunk about an inch in length, termed the right lymphatic duct. This trunk opens into the angle between the right subclavian and jugular veins; it is the termination of the lymphatics of the right arm, right side of the thorax, and of the head and neck.

Pl. 136, *fig.* 14 [1], superior vena cava; [2], azygos vein; [3], thoracic duct; [4], portion of the pelvic plexus; [5], external iliac do.; [6], lumbar do.; [7], receptaculum; [8], point of union of the chyliferous vessels of the intestinal canal, with the thoracic duct; [9,9], intercostal lymphatics; [10,10], deep lymphatics of

the lungs; [11], entrance of the thoracic duct into the subclavian vein; [12], right lymphatic duct.

Pl. 133, *fig.* 13 [1], common carotid artery; [2], internal jugular; [3], external do.; [4], axillary artery; [5], axillary vein; [6], a lymphatic vessel on the anterior of the breast; [7,7], axillary plexus; [8,8,8], superficial lymphatics of the cranium; [9,9], superficial lymphatics of the face; [10], anterior glands of the ear; [11], submaxillary gland; [12,12], lymphatic vessels and glands of the neck.

Pl. 136, *fig.* 15 [1], median vein; [2,2], superficial lymphatics of the arm; [3], axillary glands. *Fig.* 16, deep lymphatics: [1,1,1], deep veins of the forearm; [2,2,2], lymphatics accompanying them; [3], lymphatic glands in the bend of the arm; [4,4,4], veins of the arm; [5,5], their accompanying lymphatics; [6], a gland of the arm; [7], axillary gland.

Pl. 133, *fig.* 12 [1], lymphatics of the lower part of the trachea; [2], heart with its superficial lymphatics; [3,3], superficial lymphatics of the lungs. *Fig.* 6, superficial lymphatics of the foot. *Fig.* 7, superficial lymphatics of the inferior extremity: [1], lymphatics accompanying the great saphena vein; [2], superficial inguinal glands; [3], superficial lymphatics of the lower part of the abdomen and loins. *Fig.* 8, superficial posterior lymphatics of the lower part of the leg. *Fig.* 10, deep lymphatics of the anterior part of the leg: [1], anterior tibial vein; [2,2], its accompanying lymphatics; [3], anterior tibial glands; [4], superficial lymphatics of the lower part of the thigh. *Fig.* 11 *a b*, anterior deep lymphatics of the thigh and pelvis: [1], femoral vein; [2], deep femoral vein; [3], external iliac vein; [4], lumbar vein; [6,6], deep lymphatics of the thigh; [7], deep inguinal glands; [8], femoral plexus; [9], iliac plexus; [5,10], lumbar plexus.

Pl. 134, *fig.* 11, deep lymphatics of the posterior face of the thigh: [1,1], lymphatic glands of the ham; [2,2], deep lymphatics of the thigh; [3], iliac plexus; [4], lymphatic vessels between the glutæi muscles. *Fig.* 12, deep lymphatics of the posterior part of the leg: [1], posterior tibial vein; [2], peronæal vein; [3], poplitæal vein; [4,4], lymphatics of the tibia; [5], of the fibula; [6,6,6], lymphatic vessels and glands of the ham.

IV. THE NERVOUS SYSTEM.

(NEUROLOGY.)

1. General Considerations.

The nervous system, like the vascular, is distributed throughout all parts of the body, all the vital operations being subjected to its influence. It consists of two systems differing essentially in many respects, yet closely connected in many places: one, the *animal*, constituting the principal medium of communication between the organism and the external world by means of sensation, motion, and perception; the other, the *vegetative* or *sympathetic*, devoted essentially to the functions of assimilation and nutri-

tion. The two are closely related to each other, and the influence of the former on the latter is not to be mistaken.

Each nervous system has a central and a peripherical portion. The central portion of the animal system is the brain and spinal marraw, the peripherical the white thread-like nerves which proceed from these to the various organs and back again. In the sympathetic system, the central portion is constituted by two cords, one on each side of the median line of the body, with ganglia or knots placed at intervals all along.

There are two kinds of structure visible in the nervous system, the white or fibrous and the grey or cineritious. The *white matter*, with the neurilema or nerve sheath and the areolar tissue which it incloses, constitutes the whole of the nervous trunks, wherever they occur, and forms a large part of the central masses with which they are connected. It consists of tubes of great minuteness, which are composed of an interlacement of extremely delicate fibres. When examined immediately after death, the contents of these tubes appear pellucid and homogeneous, and of a fluid consistence; subsequently, however, this contained substance coagulates, and is seen distinct from its investment. The diameter of the cylindrical nervous tubuli varies from 1-2000th to 1-6000th of an inch; the fibres decrease, however, as they approach the brain. The nerve matter in the tubes originally consists of nucleated cells.

The other elementary form of nervous structure is the *cineritious* or *reddish grey matter*. It appears to consist principally of a plexus of blood-vessels into which the fibres of the first form may be traced, and amongst these lie a number of nucleated globules without any very definite arrangement. This substance is usually disposed in the interior of the larger masses with which the nervous trunks are connected. It occupies part of the interior of the spinal cord and of the ganglia, but in the brain it is disposed externally, forming a coating to the subjacent mass, which consists almost entirely of fibrous structure; hence it is called sometimes the *cortical* substance, as distinguished from the *medullary*, or the fibrous portion. The ganglion globules are from 1-300th to 1-1250th of an inch in diameter, possessing a spherical or oval form, more or less flattened, and having a reddish color. Each contains one or more nuclei with subordinate nucleoli, and is inclosed in a very fine filamentous investment, in which it is commonly found to be loosely suspended. The sheaths of the several globules are connected with each other by prolonged filaments or peduncles, and these form a kind of network, which occupies the interstices of the fine vascular plexus by which every part of the grey matter is traversed.

If we examine one of the cerebro-spinal nerves, we shall find it to be invested by a sheath of membrane already referred to under the name of neurilema. Its office is chiefly mechanical, namely, that of binding together the constituent fibrillæ and fascicles of the nerve, so as to protect them, and support the delicate plexus of capillary blood-vessels from which they derive their nutriment. To the naked eye the neurilema exhibits the appearance of a white and almost silvery membrane.

After the external part of the neurilema has been removed, the nerve

may be divided into secondary bundles composed of the ultimate or primitive fibres. The composition of these has been already referred to. They present the appearance of a series of transparent tubes placed in simple juxtaposition without any intercommunication.

The main trunk of a nerve breaks up into its component bundles, as it passes from centre to periphery, yielding up branches to the various parts it is destined to connect with the nervous centre. These branches generally come off at acute angles, and soon plunge into the muscles and other parts to which they tend, dividing and subdividing as they proceed. An exception to this mode of branching is where a branch separates from the parent trunk at an acute angle, and then turns to run in an opposite direction, forming an arch, from the convexity of which several branches are given off; such a nerve is said to be *recurrent.*

In their branchings, nerves subdivide, not only to pass immediately to their muscles or other distant parts, but also to connect themselves by certain of these filaments with other nerves, and to follow the course of the latter, instead of adhering completely to that of the parent trunk. By these means nervous filaments, connected with very different parts of the brain and spinal cord, become bound together in the same fasciculus, and a nerve is formed, compounded of tubes possessing very opposite functions. The *anastomosis* of nerves formed in this manner differs essentially from the anastomosis of blood-vessels, in there being not the slightest communication of the contents of the nervous tubes, as there is in the vascular.

The *plexuses* are nervous anastomoses of the most complicated and extensive kind. Those which are connected with the spinal nerves are found in the neck, the axillæ, the loins, and the sacral regions. There are also plexuses connected with the fifth nerve, the portio dura of the seventh, the glosso-pharyngeal, and the par vagum. Each plexus is formed by the breaking up of a certain number of nervous trunks, the subdivisions of which unite to form secondary nerves, and these again, by further interchange of fibres, give rise to nerves which emerge from the plexus, and consequently in their construction may derive their fibres from several of the trunks that enter the plexus.

The object of the anastomosis of nerves appears to be to associate together nervous fibres connected with different parts of the brain or spinal cord. In this manner, nerve-tubes of different properties or endowments become united together in one sheath, forming compound nerves; and certain sets of muscles, instead of receiving their nerves from a very limited portion of the cerebro-spinal centre, are supplied from a considerable extent of that centre, and each muscle may probably receive nerves which arise in different and distant parts of the spinal cord or brain; an arrangement whereby remote parts of those centres may be brought into connexion with neighboring muscles or other parts, or even with a single muscle.

The nerves serve to conduct impressions from the external world to the nervous centres, or to transmit volitions from these centres to the structure at large, and especially to the muscular system. The former are called *afferent* or *sensory nerves*, the latter *efferent* or *motor*, and the two are

usually bound up together in the same sheath. The precise relations of these two sets of fibrous nerves to each other and to the nervous centres will be subsequently referred to.

We shall now proceed to consider the special anatomy of the nervous system, under the heads of the brain, the spinal cord, the nerves, and the ganglions.

2. Anatomy of the Brain.

A. Membranes of the Brain and Spinal Cord.

The brain is that ganglionic enlargement of the cerebro-spinal axis seen at its anterior extremity, and characterizing the nervous system of the vertebrata, as distinguished from the invertebrata. Deferring for the present any further account of its intimate structure, we find it to be invested with three membranes or meninges: one, fibrous and external, the dura mater; one, serous and median, the arachnoid; and a third, vascular and internal, the pia mater.

1. Dura Mater. The dura mater is a dense membrane, composed almost entirely of white fibrous tissue. It has all the characters, physical and vital, of that texture, possessing great strength and flexibility, with but little elasticity. It is freely supplied with blood-vessels, and at certain situations it separates into two laminæ, which inclose prolongations of the lining membrane of the venous system, forming peculiar sanguiferous channels, known as *sinuses* (see p. 97). It has an apparently laminated appearance, from the fact of its fibres being disposed in different planes; indeed, in the child a subdivision into two layers may sometimes be easily effected. Some nerves have been demonstrated in the dura mater.

The *spinal dura mater* is in shape adapted to the vertebral canal, consisting of a hollow cylinder, tapering somewhat at its lower extremity to correspond with the sacral portion of the canal. It adheres very firmly around the foramen magnum, from which it is continued downwards to the sacrum, without forming any adhesion to bone.

On the sides the dura mater is perforated by orifices, which give exit to the roots of the nerves which arise from the spinal cord. When examined from within, these foramina are found to be arranged in pairs, each pair corresponding to the point of exit of a spinal nerve. The foramen, which transmits the anterior root of each nerve, is separated from that of the posterior root by a narrow strip of fibrous membrane. Although not attached to any part of the vertebral canal between the foramen magnum and the sacrum, yet the spinal dura mater is sustained in its position by the prolongations of its substance over the nerves at each of the intervertebral foramina. It is also decidedly larger than would be necessary merely for the reception of the spinal cord; as, when pierced, a quantity of fluid escapes, and it becomes quite flaccid, to be again rendered tense by injecting water or air.

Cranial dura mater. The dura mater of the cranium differs in one

essential point from that of the spine: namely, in that it forms a periosteum to the inner surface of cranial bones. It adheres closely to the whole interior of the cranium, and the free communication between the vessels of the dura mater and those of the bones serves materially to enhance the connexion between this membrane and the osseous surface. On the roofs of the orbits, the wings of the sphenoid bones, the petrous portions of the temporal bones, the margin of the occipital foramen, and opposite the sutures, the adhesion is very intimate.

The cranial dura mater is not a simple bag. From its internal surface partition-like processes pass inwards, which serve to separate certain subdivisions of the encephalon or brain. These are the falx cerebri, the tentorium cerebelli, and the falx cerebelli.

The *falx cerebri* is a process of fibrous membrane corresponding to the mesial plane, and lying in the great median fissure of the brain, where it separates the lateral hemispheres from each other. Its shape is falciform; its superior convex border corresponds to the frontal and sagittal sutures, and incloses the great longitudinal sinus; its inferior border is concave and much shorter than the superior, and corresponds to the superior surface of the corpus callosum, which connects the hemispheres of the brain. In front the falx is narrow, and almost pointed; it embraces the crista galli of the ethmoid bone, which appears to be inclosed between its layers. The falx cerebri contains within it, along its posterior border, a large vein, known as the inferior longitudinal sinus.

The *tentorium cerebelli* is continuous on each side with the posterior border of the falx cerebri. This process is nearly horizontal in direction. It forms a vaulted roof to a cavity, whose floor corresponds to the occipital fossæ, and in which the cerebellum is lodged. The posterior and outer edge adheres to the occipital bone, and to the posterior border of the petrous portion of the temporal. The occipital portion of this edge contains a considerable part of the lateral sinus, the portion adhering to the petrous bone containing the petrosal sinus. The anterior or inner margin of the tentorium is concave, and free in the greater part of its extent. It is attached by its anterior extremities to the anterior clinoid processes, to reach which it crosses the posterior border.

From the inferior surface of the tentorium cerebelli at its posterior edge, a short and thick fold of very slight depth descends to the posterior edge of the foramen magnum. This is the *falx cerebelli.* It corresponds to the median notch between the hemispheres of the cerebellum. Its anterior border is slightly concave. Two veins, called occipital sinuses, are contained in it.

Although the internal surface of the cranial dura mater usually presents the same smooth appearance as has been referred to in that of the spine, yet an exception is found along the great longitudinal sinus, in the occasional presence of small glandular bodies growing from the arachnoid membrane, and causing a peculiar cribriform appearance in the dura mater. These bodies, called glandulæ or glands of Pacchioni, are in all probability not normal structures, but are rather morbid products of the arachnoid produced by continued cerebral excitement.

2. The Pia Mater. The pia mater, tunica intima vel vasculosa, is the most internal membrane of those enumerated as belonging to the cerebro-spinal axis.

Pia mater of the spinal cord. This membrane stands in precisely the same relation to the spinal cord as the neurilema does to the nerves. It is composed almost entirely of white fibrous tissue, closely investing the cord, and supporting the minute blood-vessels which feed it. Not only does it form a complete sheath to the cord, but it likewise sends in processes which dip into the anterior and posterior median fissures of that organ. The spinous pia mater possesses considerable strength and density. When quite recent, it may be readily dissected off from the cord, its adhesion being through the medium of numerous exceedingly minute capillary vessels. On its exterior, the pia mater adheres to the visceral layer of the arachnoid membrane by means of a loose fibrous tissue.

Pia mater of the brain. In tracing the pia mater of the spine upwards, it will be found gradually to become thinner as it passes from the medulla oblongata to the hemispheres of the brain. Here it adheres closely to the whole surface of the brain, cerebellum, and connecting parts, numberless vessels passing from it into the nervous substance beneath. On the surface of the brain, it dips down into the furrow between the convolutions, and adheres to the superficial grey matter. At certain situations also, this membrane is continued into the ventricles of the encephalon, constituting the *choroid plexuses.*

3. The Arachnoid Membrane, intermediate between the two last described, is a great serous membrane pervading the entire cranio-spinal cavity. Its parietal layer adheres intimately to the inner surface of the dura mater, and its visceral to the outer surface of the pia mater. Like all serous membranes, it is composed of two layers, the interval between which is called the arachnoid bag or sac, and rarely contains fluid. Between the visceral layer of the arachnoid and the pia mater, is the sub-arachnoid cavity, usually including a considerable quantity of fluid. The object of this fluid is to protect the nervous centres with which it lies in immediate contact. By the interposition of a liquid medium between the nervous mass and the walls of the cavity in which it is placed, provision is made against a too ready conduction of vibrations from one to the other. Its composition, according to Lassaigne, is as follows:

Water,	98.564
Albumen,	0.088
Osmazome,	0.474
Chloride of Sodium and of Potassium,	0.801
Animal matter and Phosphate of Soda,	0.036
Carbonate of Soda and Phosphate of Lime,	0.017
	99.980

Having thus treated in brief terms of the membranes of the cerebro-spinal axis, we come next to the essential structure of this part of the

nervous system. This we shall consider under the heads of the spinal cord and of the brain or encephalon, the latter including the medulla oblongata, the mesocephalum, the cerebellum, and the cerebrum.

B. The Spinal Cord.

The spinal cord occupies a large portion of the spinal canal, terminating inferiorly at a point, which in different subjects ranges between the last dorsal and the second lumbar vertebra. Below this point, the sheath formed by the dura mater contains that series of nerves known as the cauda equina. The entire length in the adult is from sixteen to eighteen inches. Its circumference measures twelve lines at the smallest, and eighteen at the most voluminous part. Its weight is said to be from the $\frac{1}{19}$ to the $\frac{1}{25}$ of that of the brain in the adult, and about the $\frac{1}{40}$ part in the new-born infant. The actual weight of the spinal cord in the adult may be taken at a little over one ounce.

The consistence of the medullary substance of the spinal cord, when fresh, is much greater than that of the brain. The pia mater adheres very closely to its surface, like neurilema to a nerve. It is penetrated both on the anterior and posterior aspect by fissures, each of which corresponds to the median plane. They are separated from each other by a transverse bilaminate partition of white and grey matter, of which the grey layer is posterior. This serves to connect the equal and symmetrical portions into which the cord is divided by these fissures. The anterior of these fissures is deeper than the posterior. The two taken together seem to indicate the existence of two spinal cords, one for each side of the body, both presenting a perfect resemblance in form and structure.

On examining a transverse section of the spinal cord, we find that the interior of each lateral portion is occupied by grey matter disposed in a crescentic form, exactly similar in each, and connected by the grey commissure, a layer which extends between the two crescents, being attached nearly to the central point in each. This commissure forms a vertical plane of grey matter throughout the whole of the cord. The concavity of the lateral crescent is directed outwards. Their anterior extremities are thick, and separated from the surface of the cord by a considerable layer of white fibrous matter. The posterior extremities of the crescents are prolonged backwards and outwards in the form of a narrow horn, which reaches the surface of the cord. These posterior horns constitute on each side a natural boundary, between the two columns of which each lateral half of the cord consists. All in front of the posterior horns is called the antero-lateral column, comprehending the white matter forming the sides and front of the semi-cord, limited anteriorly by the anterior fissure, and posteriorly by the posterior roots of the nerves. The posterior column is situated behind the posterior horn of grey matter, and is separated from its fellow on the opposite side by the posterior fissure.

There are these four columns in the spinal cord, two antero-lateral and two posterior. The former constitute by far the larger proportion of the white substance of the cord, and they envelope the anterior obtuse portion

or horn of the grey matter. The anterior roots of the nerves are connected with them, and the posterior roots adhere to them when the cord is split up along the plane of the posterior horn. The posterior columns are small, triangular in section, and placed in opposition with each other by their inner surfaces.

The spinal nerves. There is a pair of spinal nerves for each intervertebral foramen, and for that between the axis and occiput. There are thus thirty-one pairs of nerves having their origin from the spinal cord, this number being exclusive of the spinal accessory nerve, which is connected with the upper part of the cervical region. Each spinal nerve has its origin from the cord, by two roots, of which the anterior is distinctly inferior in size to the posterior. The ligamentum articulatum (a narrow longitudinal band on each side of the cord, and intervening between the dura mater and the pia mater, attached to the latter by tooth-like triangular processes) is placed between these roots. Each root passes out through a distinct opening in the dura mater. Immediately after its emergence a ganglion is formed on each posterior root, and the anterior root lies imbedded in the anterior surface of the ganglion, and involved in the same sheath, but without mingling its fibres with those of the ganglion. Beyond it, the nervous fibres of both roots intermingle, and a compound spinal nerve results. The trunk thus formed passes immediately through the intervertebral tube, and divides into an anterior (and usually larger) and a posterior branch, which are distributed to the muscles and integument of the trunk and the extremities.

The anterior roots derive their fibres wholly from the antero-lateral columns. Of these fibres, it is probable that some are continuous with the longitudinal fibres of the cord, and that others pass into the grey matter. The posterior roots adhere to the posterior part of the antero-lateral columns, and derive their fibres chiefly from that source. It is probable, though by no means certain, that the fibres of the posterior roots have a disposition similar to that described for the anterior, and that while some pass into the posterior horn of the grey matter, others are continuous with the longitudinal fibres.

In conclusion, the spinal cord may be said to be of a cylindroidal shape, slightly flattened on its anterior and posterior surfaces. At its inferior extremity it gradually tapers to a point. In the cervical region there is a swelling or enlargement, which begins a short distance beneath the medulla oblongata, and gradually passes into the dorsal portion, which is the smallest as well as the most cylindrical portion of the cord. This cervical enlargement begins opposite the third cervical vertebra, and ends about the third dorsal. About the ninth or tenth dorsal vertebra, the lumbar swelling occurs, occupying a space corresponding to about two vertebræ. The cervical swelling corresponds to the point at which the nerves of the upper extremities are given off, and the lumbar has the same relation to the lower limbs.

Pl. 137, *fig.* 3, spinal marrow and pons from the anterior surface: [1], dura mater; [2], ligamentum dentatum; [3,3,3], single dentations of do.; [4], a spinal nerve. *Fig.* 4, a portion of the spinal marrow represented on a larger

scale: [1], dura mater; [2], ligamentum dentatum; [3], anterior root of a spinal nerve cut away; [4], do. entire; [5], a posterior root, with the ganglion; [6], anterior, [7], lateral furrow. *Fig.* 5, spinal marrow from behind: [1], posterior longitudinal furrow; [2], calamus scriptorum; [3], posterior column; [4], its division by a furrow into halves. *Figs.* 9, 10, 11, cross sections of the spinal marrow beneath the medulla oblongata.

C. The Encephalon.

The term encephalon is conveniently employed to denote the portion of the cerebro-spinal axis which is contained within the cavity of the cranium. Before proceeding to the description of the individual portions of the encephalon, it will be proper to premise some general considerations, borrowed from Tiedemann, having reference to its entire mass.

The average weight of the human brain amounts to about 48 ounces for the male, and 44 ounces for the female. The brain of men who have been distinguished for their intellectual attainments has often been found to exhibit a large size. That of Cuvier weighed 3 lbs., 11 oz., 4 dr., 40 gr. On the other hand, the brain of an idiot, fifty years old, weighed but 1 lb., 8 oz., and 4 dr.

The brain attains its full size, on an average, about the seventh or eighth year.

The brain of the new-born child is, relatively to the size of its body, the largest. The proportion is as 1 : 6. It decreases in proportion as man attains his full growth. Thus, in the second year the proportion of the brain to the body is as 1 : 14; in the third, 1 : 18; in the fifteenth, 1 : 24.

Although the female brain is absolutely smaller than the male, yet relatively to the size of the body it is usually larger.

1. Surface of the Encephalon. The brain, in horizontal projection, is seen to be of oval shape, the smaller end of which is directed forwards. The superior and lateral surfaces are convex, and have a smooth appearance, from the visceral layer of arachnoid being spread over them. When the membranes have been removed, the surface of the brain is seen to be impressed with numerous convolutions.

The superior surface is divided along the median plane into two equal and nearly symmetrical portions by a vertical fissure, which receives the great falx of the dura mater. In front and behind, this fissure completely divides the central lobes. In the middle, the fissure is interrupted by a horizontal lamina of white fibres, called the *corpus callosum*, the great commissure of the cerebral hemisphere. The inferior surface of the brain presents three segments each on a different plane, and corresponding with the three fossæ of the cranium. The anterior segment, and the one on the highest level, correspond to the anterior fossa of the cranium, and rest upon the roofs of the orbits. The continuation of the anterior median fissure separates its right and left portions, this distinction being rendered more complete by the attachment of the falx to the crista galli of the ethmoid. In a distinct sulcus, parallel to and immediately on each side of the longitudinal fissure, we find the olfactory process or nerve. A curved fissure of con-

siderable depth, called the *fissure of Sylvius*, is the posterior limit of each anterior segment. The fissure of Sylvius corresponds on each side to the posterior concave edge of the ala of the sphenoid bone, which is received within it. Commencing from within, at a triangular flat surface (*locus perforatus anticus*), at the posterior extremity of each olfactory process, it proceeds outwards and curves backwards, its convexity directed forwards to the lateral surface of the brain. It is of considerable depth, especially at its internal extremity, and like all fissures of the brain, is lined by pia mater. The *island of Reil* is found at the bottom of this fissure, projecting from its floor as a small insulated lobe, bounded by a bifurcation of the fissure.

The *middle segment*, which lies immediately behind the fissure of Sylvius, is on a plane much lower than the anterior, and corresponds on each side to the deep and hollow median fossa of the cranium. It consists of two lateral, very convex lobes, known as the *middle lobes of the brain*, which are separated from each other by a deep depression. These lobes, which are distinctly defined in front by the fissure, have no exact boundary behind, but pass off very gradually into the *posterior lobes* of the hemispheres, as may be seen by raising up the cerebellum.

Commencing at the anterior fissure and passing backwards we shall perceive the following parts. This fissure is limited by the anterior fold or reflexion of the corpus callosum; behind this is a thin layer of a greyish color which principally constitutes the floor of the third ventricle, and is known as the *tuber cinereum.* The *pituitarg process* is continuous with it, being probably its extension, and is a hollow process of nervous matter above the sella turcica by which the brain is in a measure tied to the pituitary body.

Immediately in front of the pituitary process, the union of two white bands, which form lateral boundaries to a large portion of the tuber cinereum, the *optic tracts*, takes place along the median line. This forms the *commissure* of the optic nerves from which these nerves diverge. Behind the pituitary process, the tuber cinereum extends back to two small and very white bodies called *corpora mammillaria* or *albicantia.*

Behind the mammillary bodies, we find a deep depression, lying between two thick processes of fibrous matter, which pass from below upwards and outwards, expanding as they advance, and upon which each hemisphere is sustained like a mushroom on its stalk. These are the *crura cerebri*, the peduncles of the cerebral hemispheres. The depression separating them is the *intercrural space.* The nervous matter forming the floor of this space is of a greyish color and known as the *pons Tarini.* The third pair of nerves emerges from the interpeduncular space.

The inner margin of each middle lobe of the brain is separated from the corresponding crus cerebri by a fissure which passes from behind forwards, and terminates in the fissure of Sylvius. Backwards this fissure is continuous with the transverse fissure separating the cerebrum from the cerebellum, and corresponding to the posterior edge of the corpus callosum. The continuity thus established between these three series of fissures constitutes the *great cerebral* or *transverse fissure.*

The *posterior segment*, as occupying the posterior fossa of the cranium, is on a level considerably below that of the middle segment. A part worthy of especial notice is the *pons Varolii*, which is situated immediately behind the interpeduncular space, the crura cerebri appearing to emerge just above its anterior border. From its posterior edge the medulla oblongata extends downwards and a little backwards, occupying a notch or depression between the lobes of the cerebellum. The fibres of the pons are seen passing outwards and backwards into each hemisphere of the cerebellum, forming the inferior layer of each crus cerebelli.

2. Dissection of the Encephalon. If we make a horizontal section of one hemisphere, nearly on a level with the *corpus callosum*, we shall perceive what is known as the *centrum minus ovale*, a mass of white fibrous substance surrounded by an irregularly undulating line of grey; a second horizontal section passing through both hemispheres on a level with the corpus callosum presents the *centrum magnum ovale*, a line of grey substances surrounding the central mass of white. The *corpus callosum*, or superior cerebral commissure, will now be seen in the middle line of the cerebrum, between three and four inches long, marked by two or three raised longitudinal lines nearly parallel to each other (the *raphe*); from these, several transverse lines pass to either side. The posterior end of the corpus callosum is bent downwards above the transverse fissure, and is continuous with the fornix and hippocampi; anteriorly it is continued into the anterior lobes: in the middle it joins the tuber cinereum and the optic commissure. It connects the white fibrous substance of both hemispheres, and covers like an arch the lateral ventricles, the septum lucidum, and the fornix.

On dividing the corpus callosum at a little distance from either side of the raphe, the lateral ventricles or cavities of the brain will be opened, one on each side, and separated by the *septum lucidum*. This consists of four laminæ on each side: 1. The lining membrane of the ventricle; 2. A thin grey layer; 3. A compact white fibrous layer; 4. A delicate membrane which lines the small cavity existing in it, and termed the *fifth ventricle*.

The *lateral ventricles* extend from the middle of the brain into the anterior and posterior lobes, also into the inferior part of the middle lobe; each has, therefore, three cornua. The anterior cornu is bounded superiorly and laterally by the corpus callosum, and inferiorly by the large extremity of the corpus striatum. The middle or body of each ventricle is bounded superiorly and externally by the corpus callosum; internally by the septum lucidum, and inferiorly by the posterior extremity of the corpus striatum, the lamina cornea, the tænia semicircularis, the optic thalamus, the choroid plexus, and the fornix. The posterior cornu is bounded superiorly and laterally by white substance, and inferiorly by the hippocampus minor. The inferior cornu is bounded superiorly by the optic thalamus and corpus striatum; inferiorly by the hippocampus major and corpus fimbriatum or tænia hippocampi, over which the choroid plexus is folded.

In making a brief individual reference to the different bodies observed in

each lateral ventricle, we commence with the *corpus striatum*, a pear-shaped eminence situated in the anterior horn, the obtuse extremity directed forwards and inwards. Posteriorly the body is apparently prolonged backwards into the inferior cornu of the lateral ventricle by a long tapering process, which terminates there. Internal and posterior to the corpus striatum is the *optic thalamus*, a gangliform body of greyish color. These two bodies are separated from each other by a superficial groove, in which lies a delicate band of fibrous matter, the *tænia semicircularis*, which is covered by a lamina of horny-looking matter, the *lamina cornea*.

The *choroid plexus* is a fold of thin and very red vascular membrane derived from the pia mater, which enters the inferior cornu by the great cerebral fissure, and ascending, turns inwards just behind the septum lucidum and anterior pillars of the fornix, and unites with its fellow of the opposite side, covering and nearly concealing from view the optic thalamus.

In the posterior cornu, there is seen in its internal wall a projection upwards of one of the convolutions, to which the name of *hippocampus minor* has been given. It is traversed by a deep furrow. In the descending horn is a remarkable prominence, the *hippocampus major*, projecting into it from the inferior wall and following the curve of the horn. Beneath this is a peculiar grey matter, connected with the hippocampus, known as *fascia dentata*. A thin margin from the fornix which overlaps the hippocampus is called the *corpus fimbriatum*.

The *fornix* is a white, fibrous, triangular arch or vault, convex above, situated horizontally beneath the corpus callosum and septum lucidum; it lies on the velum interpositum and choroid plexuses, and over the third ventricle. The base, posteriorly, arises by two long flat bands (*the posterior pillars* or *crura*), one from either side, by three roots, from the hippocampus major and minor and from the tænia hippocampi; these crura unite to form the *body* of the fornix, which bending forwards divides into two short round cords, the *anterior pillars of the fornix*. The inferior surface of the fornix is marked posteriorly with several fine oblique lines (*lyra* or *corpus psalloides*); although described as single it is really double, and divisible throughout except where the lyra unites opposite sides. It may be called the *great inferior commissure* of the cerebrum, the corpus callosum constituting the great superior commissure. The anterior pillars of the fornix bound a space in front, through which the lateral ventricles communicate with each other through the *foramen commune anterius*.

The *third ventricle*. If the fornix be divided transversely at about its middle, and the segments reflected, the velum interpositum being removed, a fissure known as the *third ventricle*, and situated between the optic thalami, will be exposed. Anteriorly and between the anterior pillars of the fornix this fissure is limited by a band of white matter called the anterior commissure. At its posterior extremity the third ventricle becomes much contracted in all its dimensions, and is continuous with a canal (*aqueductus Sylvii*) which leads to the fourth ventricle. The roof of the third ventricle is formed by the velum interpositum.

The *pineal gland.* This body, rendered famous by the vague theory of Descartes, which viewed it as the chief source of nervous power, is placed just behind the third ventricle, resting in a superficial groove which passes along the median line between the corpora quadrigemina. It is of a greyish color, heart-shaped, with the apex directed backwards and downwards. A process from the deep layer of the velum interpositum envelopes it and retains it in place. From each angle of the base there passes off a band of white matter to the inner surface of each optic thalamus, called the *peduncles* or *habenæ* of the *pineal gland.* The only connexion with the brain is by means of these habenæ. In the adult, grains of sandy matter are usually found in the pineal gland, which are mostly collected in a cavity towards its base; sometimes, however, situated on the surface.

The *soft commissure* is a lamina of light grey matter, situated in the third ventricle, and extending between the optic thalami of opposite sides. It forms a transverse horizontal plane dividing the ventricle into two portions.

We come next to consider that part of the brain which lies intermediate to the cerebrum, cerebellum, and medulla oblongata, and conveniently termed the *mesocephalon.* The pineal body rests upon its upper surface; but from its internal relation to the third ventricle and optic thalami, we found its description with them most convenient.

3. The Mesocephalon. The limits of the mesocephalon cannot readily be defined, as it is continuous with the crura cerebri above, with the crura cerebelli behind, with the medulla oblongata below, and with the cerebellum itself above and behind. Many treat of it as one mass with the medulla oblongata. We shall consider it as composed of the tubercula quadrigemina and the pons Varolii.

The *corpora*, or *tubercula quadrigemina*, are four eminences seen immediately behind the third ventricle. A transverse furrow separates them into an anterior, the *nates*, and a posterior pair, the *testes;* a longitudinal furrow along the median line divides the right and left pairs from each other. The pineal body rests in the anterior extremity of the longitudinal depression.

The posterior crura of the corpora quadrigemina are connected with the cerebellum by two columns of white matter, one of which passes into the central white substance of each cerebellar hemisphere; these are the *processus cerebelli ad testes.* They enter into the formation of the crura cerebelli. The interval between the two processus cerebelli is occupied by a horizontal stratum of nervous matter called the *valve of Vieussens*, or *of the fourth ventricle.*

The pons Varolii, or *great commissure of the cerebellum*, is somewhat square, and placed obliquely on the cuneiform process between the cerebrum and the cerebellum. The fourth ventricle, the aqueduct of Sylvius, and the corpora quadrigemina are on its superior and posterior surface. Its superior extremity receives the crura cerebri, which it surrounds like a ring, and is hence sometimes called the annular protuberance; the crura cerebelli are attached to its sides, and the medulla oblongata to its lower

extremity, from which it is distinguished by a deep groove. Its surface is white and fibrous: the superficial layers of fibres on its inferior surface run transversely from the inferior surface of one crus cerebelli to the other.

4. The Cerebellum. The cerebellum is seen on removing the posterior lobes of the cerebrum and dividing the tentorium. In size and weight it bears to the cerebrum a ratio of about as one to eight; the average weight of the cerebrum being two pounds and a half, that of the cerebellum amounting to about four ounces and a half. It is somewhat different in form from the cerebrum, being oval transversely, and raised in the centre, where its right and left hemispheres are united. Like the cerebrum it is composed of white substance internally and of grey upon its surface, upon which it is marked by a great number of parallel narrow lines, running semicircularly convex posteriorly; these are fissures to the bottom of which the pia mater descends, the arachnoid membrane passing over them. Some lines called *primary* pass very deep into the cerebellum, and divide it into lobes; *secondary* lines, more superficial, divide these into lobules.

The cerebellum presents for examination a superior and inferior surface, a convex border or circumference, and a median notch behind and before. The *posterior notch* is very deep. It receives the falx cerebelli and the inferior occipital crest, and extends close along the under surface as far as the back of the medulla oblongata. This extension is called the *valley* or the *purse-like fissure.* The *anterior notch* is broad, overlaps the fourth ventricle, and embraces the central protuberance and tubercula quadrigemina. These two notches mark a division of the cerebellum into right and left hemispheres, the circumference of each of which is deeply indented by the *horizontal fissure.*

The superior surface of the median portion of the cerebellum is known as the *superior vermiform process.* Its anterior terminal laminæ form the valve of Vieussens. On the inferior surface the hemispheres are much more convex than on the superior. The median portion consists of a series of laminæ following a transverse direction, those in the centre being of greater transverse extent than those at either extremity, and constituting the *inferior vermiform process.* These two processes, which have thus received distinct names, are really but one, and might be properly termed the median or primitive lobe of the cerebellum. In the lower orders of vertebrata this median lobe alone exists, the lateral portions increasing with the ascent in the organic scale.

The cerebellum may therefore be considered as divided into the median lobe and two lateral hemispheres. The hemispheres present the lines or sulci already referred to, on their superior surface, dividing them into lobes and lobules. We can only briefly indicate these divisions in a general survey of the entire cerebellum as follows:

a. The cerebellum is divided into three parts, viz. right and left hemispheres, and middle or primary portion. *b.* Each of these is subdivided by the horizontal groove into superior and inferior. *c.* The upper surface of each hemisphere presents two lobes, the anterior or square, and the posterior

or semilunar. The two former are connected by the tortuous transverse laminæ of the superior vermiform process, and the two posterior by those forming the floor of the posterior notch. *d.* The median portion presents the single or azygos superior median lobe or vermiform process. *e.* The inferior surface of each hemisphere presents five lobes. Most anterior and distinct from the hemisphere are: first, the flocculus or pneumogastric lobule, connected to its fellow and to the nodule by the inferior medullary velum; second, the tonsilic lobe or amygdalar, on the side of the ventricle, and connected to the opposite through the uvula or spigot; third, the digastric; fourth, the gracilis; fifth, the semilunar, which is joined to its fellow by the convex transverse laminæ at the bottom of the posterior notch; sixth, the inferior median lobe, or vermiform process, presents from before backwards three lobules; the nobule most anterior, next the uvula or spigot, and posteriorly the pyramid.

The *fourth ventricle* is a lozenge-shaped cavity, situated in the upper and posterior part of the medulla oblongata, and formed by the separation of its postero-lateral columns (corpora restiformia). The cerebellum contributes to inclose it by means of the anterior laminæ of the superior vermiform process and the valve of Vieussens, and below and behind by the inferior vermiform process.

5. Medulla Oblongata. The medulla oblongata, or spinal bulb, is that conical portion of white substance which extends from the lower margin of the pons Varolii to the spinal cord, on a level with the ring of the atlas. Its upper end or base, though apparently limited by the pons, is prolonged upwards through it to the crus cerebri of each side. Inferiorly, there is no distinction between it and the spinal cord posteriorly or laterally. It presents an anterior and posterior median fissure, which divides it into two symmetrical portions, each of which is marked by three grooves and four convex eminences, viz. the anterior pyramid, the corpora olivaria, the corpora restiformia, and the posterior pyramid.

The *posterior fissure* is continuous with that of the spinal cord. It is narrow, deep, and lined by the pia mater. The *anterior fissure*, the continuation of the spinal, is broader but shallower, and lined by transverse commissural fibres. Nearly an inch below the pons this fissure is interrupted by the *decussating fasciculi*, three or four in number, which ascend obliquely inwards from the lower end of each pyramid to the opposite one, interlacing or interdigitating with each other.

The *anterior pyramids* are two narrow, convex, white bands, about an inch long, small inferiorly, and partially united by the decussating fasciculi. They appear to be the direct as well as decussating medium of communication between the anterior fibres of the cord, the mesocephalon, crura cerebri, corpora striata, and cerebral hemispheres.

The *corpora olivaria* are smaller and shorter than the pyramids, are external and posterior to these, and separated by a groove both from them and from the restiformia. They only exist in man and quadrumana. White and fibrous externally, when divided they present a mass of grey neurine called *olivary ganglion* or corpus dentatum.

Corpora restiformia, or the *inferior peduncles of the cerebellum*, are two thick longitudinal white cords on each lateral and posterior surface of the medulla, separated from the olivaria by a groove, in which the roots of the eighth pair of nerves are lodged. Each of these connects the spinal cord and the medulla oblongata with the cerebellum.

Posterior pyramids are two long narrow columns which extend on each side of the posterior fissure of the cord to its lower extremity. They are seen on each side of the calamus scriptorius in the lower part of the ventricle, and terminate abruptly. By their deep surface they appear continuous with the posterior part of the olivary tracts.

Pl. 137, *fig.* 1, view of the brain from above. *Fig.* 2, base of the brain: [1], continuation of the great median fissure along the inferior surface of the brain; [2], anterior cerebral lobes; [3], fissura Sylvii; [4], middle cerebral lobe; [5], commissure of the optic nerves; [6], tuber cinereum, with the process proceeding from the pineal gland; [7], corpora mammillaria; [8], crura cerebri; [9], pons Varolii; [10], cerebellum; [11], limit of the superior lobe of the cerebellum; [12], the flocculus; [13], inferior vermiform process; [14], anterior pyramids; [15], olivaria; [16], restiformia; [17], olfactory nerve; [18], optic nerve; [19], motor oculi; [20], trochleator; [21], trigemini or fifth pair; [22], abducens nerve; [23], facial and auditory nerves; [23'], glosso-pharyngeal and pneumogastric nerve; [24], accessory nerve; [25], lingual nerve. *Fig.* 3 [5], lingual nerve; [6], glosso-pharyngeal, pneumogastric, and accessory nerves; [7], facial and auditory nerves; [8], trigemini; [9], abducens oculi; [10], optic nerve; [11], cauda equina; [12], lumbar enlargement of the spinal cord; [13], cervical do.; [14], medulla oblongata; [15], anterior spinal fissure; [16], lateral do.; [17], olivaria; [18], pyramids; [19], pons; [20], crura cerebri. *Fig.* 6, medulla oblongata; [1], fibres separating to inclose the corpora olivaria; [2], lateral fibres; [3], point where these decussate; [4], posterior fibres of the olivary column; [5,5'], pyramids; [6,6'], their continuations into [7]; and [7], the crura cerebri. *Fig.* 7, cross section of the corpora olivaria: [1], their cortical substance; [2], corpus dentatum; [3], medullary substance. *Fig.* 8, vertical section of the pons Varolii, and of the medulla oblongata. *Fig.* 12, cross section at the point of decussation of the pyramidal columns. *Fig.* 13, cross section of the central portion of the medulla oblongata. *Fig.* 14, cross section at the point of union between the medulla oblongata and the pons.

3. Psychological Relations of the Brain.

Numerous experiments have been made by accomplished physiologists to determine the modus operandi of the brain as the source of voluntary action and the recipient of sensitive impressions. We may point to a few general conclusions as tolerably well established by careful research, although still open to examination. They are as follows:

1. The vesicular matter of the brain is the source of nervous power. In mental actions it is the part immediarely associated with changes of the

mind, whether in the working of the intellect, or in the exercise of the will, or in the perception of sensitive impressions.

2. In simple operations of thought, as in the exercise of the reasoning powers, or of those of the imagination, the convolutions of the brain are immediately engaged. We do not say that material changes give rise to the mental actions, but rather that the changes of the immaterial mind and those of the vesicular matter of the convolutions are simultaneous.

3. The simple exercise of the will for a voluntary movement is probably connected with the corpora striata.

4. The mere reception of sensitive impressions is connected with the optic thalami and the superior layers of the crus cerebri.

5. Mental emotions affect the posterior and superior part of the mesocephalon.

6. The cerebellum is the regulator of the locomotive actions.

The harmony of the cerebrum is affected by various causes, whose influence is then exhibited in abnormal mental or bodily phenomena. A violent concussion or a severe electrical shock may either produce immediate death, or else cause stupefaction, loss of memory, wandering of mind; turning the body rapidly round causes vertigo. The excessive use of ardent spirits or narcotics may effect the same result, delirium, insanity, and lethargy following in their train. The poet may have his inspiration excited and increased by wine, the use of which would only blunt the calm reflection of the mathematician.

These brief indications may serve to introduce the subject of *Phrenology* or *Cranioscopy*, the science which professes to decide upon the mental peculiarities of man and animals, from the form and relations of certain portions of the exterior of the skull.

This subject was first elaborated by Gall, born at Tiefenbrun in Swabia, March 9th, 1757. For a time settled in Vienna as a physician, he subsequently moved to Paris, where he died August 22d, 1828. He well knew that it was the brain and not the skull that was connected with the mental phenomena, yet as it was impossible to have access to the former in the living individual, he took the latter as its measure, assuming the exterior of the skull to be an exact model of the inequalities on the surface of the brain. Associating himself with Spurzheim, a former pupil, Gall endeavored to bring his hypothesis to the rank of a well established theory. In the following article we present the principal features of their science.

A. Phrenological System of Gall and Spurzheim.

The mental powers of an animal are numerous in proportion to the complexity of its brain; the remarkable diversities in the structure of the brain in different animals stand in immediate relation to the special variations in their mode of life and general functions.

In all organized beings different phenomena presuppose different organs; thus the different functions of the brain imply different organs.

One animal possesses inclinations and instincts which are wanting to

another; this is only explicable on the supposition that every special function of the brain is limited to a particular portion of it.

The gifts and peculiarities found in all individuals of the same species exist in different degrees in the different individuals; this can only be explained by a difference in the activity of the different organs regulating these peculiarities.

In the same individuals the different original gifts are found in very different degree; this could not be were not each original mental peculiarity dependent on a special organ.

The essentially different functions of the brain never present themselves simultaneously either in man or in animals: some are constant, while others acquire a maximum development, either with the age of the subject, or the season of the year. This cannot be explained on the supposition that all functions are dependent on a single organ.

A too long continued exercise of the mind does not enfeeble or weary all the mental powers equally: the fatigue is only partial, and rest can be attained by changing the subject of study, without the necessity of entire cessation from labor. This would be impossible if the whole of the brain were concerned in any species of mental application. Certain mental and moral powers may be destroyed, blunted, or heightened by disease, wounds, &c., while others remain entirely unaffected by the same causes: this would be incomprehensible on the supposition that the brain is a single uniform organ adapted equally to all functions.

Litle exception can be taken to the postulates of Gall as above presented: the case is different, however, in respect to the conclusions which he attempts to draw from them. According to him all the organs of the mind lie on the surface of the brain in the different convolutions, and they are more or less depressed or elevated, are larger or smaller as their functions are exercised with greater or less energy. These different developments of the brain are supposed to be impressed on the surface of the cranium, and externally visible. To this, however, positive facts of anatomy and physiology are decidedly opposed. According to the present state of our knowledge of the functions of the brain, it is not upon the surface that we are to seek for the seat and impress of mental characteristics, but rather on the walls of the ventricles whose varying features are not exhibited on the surface of the brain, much less on the exterior of the cranium. The most accurate anatomico-physiological investigations lead to the conclusion that in men of high mental endowments the regions of the posterior and inferior cornua of the lateral ventricles are especially developed, yet these are so entirely concealed from view as to yield no definite conclusions in the unopened cranium.

On *pl.* 120, *figs.* 15, 16, 17, the organs as originally established by Gall will be found indicated by the figures 1 to 27, as follows:

1. Sexual love. 2. Love of children. 3. Capacity for communicating instruction. 4. Knowledge of the relative positions of objects. 5. Knowledge of persons. 6. Sense of color. 7. Sense of melody and harmony. 8. Talent for calculating. 9. Facility in expressing thoughts in writing.

10. Fluency of speech. 11. Power of construction. 12. Friendship; attachment; fidelity. 13. Courage; power of self-defence; tendency to bullying. 14. Disposition to destroy life. 15. Tendency to conceal mental emotions. 16. Propensity to steal; to acquire property, &c. 17. Pride; arrogance; self-respect. 18. Love of approbation; vanity. 19. Cautiousness; prudence; excessive timidity. 20. Power of comparison, or of discovering analogies. 21. Metaphysical acumen; tracing the relations of cause and effect. 22. Wit; disposition to mirth. 23. Poetic feeling; ideality; love of the beautiful. 24. Benevolence of disposition; good humor. 25. Religious feeling. 26. Firmness; obstinacy. 27. Mimicry; power of imitation.

The regions of the skull marked ? were left unnamed by Gall.

The hypothesis of Gall, which for a time counted numerous adherents, was subsequently almost entirely forgotten, and only resuscitated in more modern times by the labors of English and American investigators. Although the general principles remained the same, the number of organs was increased from twenty-seven to thirty-six, and the name of the science changed from Cranioscopy to that of Phrenology.

Some phrenologists, with Noel, assume the following six regions as connected with the mental faculties: 1. *The posterior basilar region*, containing the cerebellum, and supposed to be the seat of the instinct of reproduction. 2. *The lateral basilar region*, the region of the ear; the seat of the inferior, selfish feelings; the propensities to self-aggrandizement, distinction, &c. 3. *The posterior region of the head above the cerebellum*, the seat of social qualities, love of children, attachment, fidelity, &c. 4. *The region of the vertex*, or *crown of the head*, the seat of the higher egotistical feelings, as self-esteem, love of approbation, &c. 5. *The anterior superior portion of the head*, the seat of the higher moral and religious sentiments, as benevolence, veneration, firmness, conscientiousness. 6. *The forehead*, the seat of the intellectual organs, the perceptive being situated in the lower part, the reflective above.

We shall now, in conclusion, present the order in which the different mental faculties are mapped out by phrenologists of the present day, referring to *pl.* 120, *figs.* 18–21.

A. Propensities or Instincts. 1. *Amativeness:* lies between the occipital condyles.

2. *Philoprogenitiveness:* lies above the middle of the cerebellum. Its form varies; in some it is an oval elevation, as in females; in others it is more elongated.

3. *Inhabitiveness:* beneath Self-Esteem. It produces the desire of permanence in place.

4. *Concentrativeness:* lies between Philoprogenitiveness and Inhabitiveness. The power of concentrating all the faculties on one point.

5. *Adhesiveness:* on each side of the preceding. Attachment, friendship, love of society.

6. *Combativeness:* situated on each side, at the inferior posterior corner of the parietal bones.

7. *Destructiveness:* immediately above the external ear, extending on each side.

8. *Secretiveness:* immediately above Destructiveness. When the two last organs are highly developed, the cranium acquires a peculiar shape in the extension or prominence of the inferior lateral portion.

9. *Acquisitiveness:* situated at the anterior inferior angle of the parietal bone.

10. *Constructiveness:* situated at the inferior lateral portion of the frontal bone, in the vicinity of the sphenoidal suture.

B. SENTIMENTS. 11. *Self-Esteem:* lies on the posterior portion of the top of the cranium; when strongly developed, it constitutes the vertex, or highest part of the head.

12. *Love of Approbation:* on each side of the preceding.

13. *Cautiousness*, running into prudence and timidity: a little below the middle of the parietal bone.

14. *Benevolence*, the source of compassion: lies on the upper part of the frontal bone.

15. *Veneration:* tendency to respect what is great and good; lies between Firmness and Benevolence.

16. *Firmness:* placed in the posterior portion of the coronal suture.

17. *Conscientiousness:* anterior to Hope, lateral to Firmness.

18. *Hope:* on either side of Veneration.

19. *Wonder*, *Credulity:* on one side of Benevolence.

20. *Ideality:* love of the beautiful, desire for excellence; on one side of Wonder.

21. *Imitativeness:* next to Benevolence.

C. INTELLECTUAL FACULTIES. 22. *Individuality:* takes cognisance of existence and simple facts; lies in the lowest part of the forehead, immediately above the root of the nose.

23. *Form:* idea of external shape; situated at the interior angle of the orbit.

24. *Size:* gives the idea of space, and enables man to appreciate distance and dimension; placed at the interior angle of the superciliary arch.

25. *Weight:* communicates the perception of momentum, weight, and resistance, and aids equilibrium: lies behind the preceding, on the superciliary arch.

26. *Color:* gives perception of colors and their harmonies; lies a little beyond the middle of the superciliary arch, next to the preceding.

27. *Locality:* idea of relative position; placed on each side, at the middle of the inferior edge of each frontal bone.

28. *Number:* above the outer angle of the eyebrows.

29. *Order:* the love of physical arrangement; lies next to Color, and forms the outermost organ in the superciliary arch, bordering externally on Number.

30. *Eventuality:* takes cognisance of occurrences or events; lies in the middle of the forehead.

31. *Time:* borders on Sound, Eventuality, Locality, and Wit.

32. *Tune:* a considerable development enlarging the anterior portion of the forehead, and giving to it an angular shape: said to be very conspicuous in Liszt. It appears to have been pyramidal in Gluck and Haydn, and rounded in Mozart, Viotti, Zumsteeg, Dussek, and Crescentini.

33. *Language:* situated on the anterior inferior portion of the anterior lobe of the brain, immediately above the vault of the orbits. In proportion to its development, it depresses the vault of the orbit, forcing out, and giving a fulness to the eyes.

D. THE INTELLECTUAL REFLECTIVE FACULTIES. 34. *Wit:* lies beneath the inferior external portion of Wonder.

35. *Comparison:* lies beneath the organ of Benevolence. This and the next organ sometimes constitute a single lump.

36. *Causality:* traces the relation of cause and effect, and the dependence of phenomena; lies beneath Imitation, and borders on Wonder, Benevolence, Comparison, Eventuality, and Time.

We may characterize the *instinct of nourishment*, and the *love of life*, as acquired faculties. Their supposed locations are indicated by ⊕ and ✢ on *fig.* 19. The regions marked ? are uncertain.

The More Modern Methods of Cranioscopical Investigation.

The first point to be ascertained is as to the general size of the cranium to be examined, whether it be large, of medium size, or small. We next consider the relative extent of the principal regions of the cranium as already referred to, going into an estimate of the individual organs present, with reference to their length, breadth, and thickness; by this means we obtain an idea of their mutual relations. The head in question is next to be examined in profile, dividing it into two portions by means of a vertical line (*pl.* 120, *figs.* 1, 2, *a b*), which extends from the opening of the external ear *a*, to the central point *b*, of the upper part of the head, corresponding to the intersection of the frontal and sagittal sutures. The posterior surface is the occipital, and the anterior the frontal region; the extent of each is next to be determined. In *fig.* 1, the occipital region *a b d* predominates over the frontal *a b c;* the reverse is seen in *fig.* 2. The former condition is the more common, indicating a preponderance of the animal over the intellectual in man. In each figure now draw lines *a c*, *a f*, *a b*, *a d*, from the external auditory meatus; these lines, by their different lengths, will indicate the different degrees of cerebral development in the different planes of intersection. Next examine the length *c d*, from the occipital to the frontal region, as also the height of the head *a b*, from the ear to the vertex. Then divide the head, with respect to its height, into two regions, by means of a horizontal line *c d*, from the middle of the frontal region to the point of union of the parietal bones and the occiput. The portion below this bone is called the basilar region, that above it the coronal. Of these two regions, the former will usually be found most highly developed; another indication of the preponderance of the animal. A line *e f*, drawn from the outer corner of the eye, vertical and parallel with *a b*, indicates the degree of development of the brain in the fore-

head proper; as also the volume of its lower portion *e c*, with that of the upper *c f*. The former of these bears reference to the perceptive faculties, the latter to the reflective.

Finally, take the entire circumference of the head into consideration, and compare the height with the breadth, by which means we shall obtain the relation between the lateral and the superior region. The usually greater development of the lateral region in proportion to that of the fore part of the head, again points to the preponderance of the animal in man. We may next proceed to the consideration of the single organs situated in each of these regions.

In the frontal part of the head lie the intellectual faculties, the perceptive being inferior and the reflective superior. All the rest of the head belongs to the feelings; the basilar and lateral portions to the instincts, the vertical to the feelings. The part *adb* of the region of the vertex deserves especial mention, on account of the influence which the organs situated in it exercise upon the operations of all the rest, exciting and communicating a greater degree of energy to them. This part of the head, in connexion with a well developed frontal and vertical region, imparts strength both to the intellectual and the moral faculties, while in connexion with a high development of the basilar region it invigorates the animal impulses.

Quite recently Carus has endeavored to establish Cranioscopy on a more scientific basis than hitherto. He starts with the principle that the skull consists of three vertebræ, and that these three vertebræ correspond to the three divisions of the brain, anterior, middle, and posterior; which in turn stand in strictest relation to the three directions of spiritual activity, the intellect, the sensibility, and the will. He made use of every opportunity in his power to obtain measurements of the most diverse heads, comparing, too, a great number of skulls and plaster casts, and from his different examinations attained to the following noteworthy results. We may remark that the measurements given are in the German inch, which is slightly larger than the English.

He never found that among men in whom there existed a deficient development of the anterior or frontal vertebra (in height less than 4 inches 6 lines measured from the opening of the ear, and a breadth of forehead less than 4 inches) there was any decided intellectual development. On the other hand, in an extensive series of remarkably intellectual individuals he found the volume of the frontal vertebra to be always considerable (5 inches to 5½ high and 4½ to 5 inches broad). As instances Carus adduces Kant, the great metaphysician; Ehrenberg, the naturalist; Retzius of Stockholm, the anatomist; Von Raumer, the historian; Von Lindenau, the statesman; the artists, Rauch (5 inches 4 lines high, 4 inches 7 lines broad), Bendemann, and Thorwaldsen (5 inches 2 lines high, 4 inches 8 lines broad); the poets, Schiller, Goethe, and Tieck: in all these there was a striking anterior development. In the head of the Italian philosopher Nobili alone did he find so slight dimensions as a height of 4½ inches, and a breadth of 4⅓, and in his case the whole skull was very delicately organized, the bones

of the forehead very thin, with a considerable breadth of the tympanic vertebra ($5\frac{1}{2}$ inches).

In a series of measurements of the heads of very intelligent and highly gifted women, he never found so great a height of forehead as in eminent men. The greatest size occurred in the authoress Mrs. Austin.

Measurements of the middle and posterior regions of the head gave frequent occasion to recognise the relation between them and the sensibilities and will. With a middle region of only 5 inches or less, the skull always belonged to a low depraved nature. Two convicted thieves exhibited a height of 4 inches 10 lines and 5 inches 1 line, with a breadth of 5 inches 2 lines. In the skulls of various savage tribes, as New Hollanders, Botocudas, Guaraguanas, Aleutians, Negroes, Baschkirs, &c., the height was only 4 inches 5–10 lines, and the breadth 4 inches 1–8 lines. On the other hand, in poets, artists, and savans, the height amounted to 5 inches 4–7 lines, and the breadth to 5 inches 5–9 lines. With respect to the hind part of the head, its height was always characteristic of energy of action; whether this was spiritual or corporeal in its nature, depended upon the greater or less development of the region of the intellect. Thus a very muscular Arabian springer was distinguished by an enormous height of occipital vertebra (4 inches $5\frac{7}{8}$ lines); while in other more spiritually gifted persons of great power of will it amounted to 3 inches 7 lines to 5 inches, by 4 inches 4–5 lines (in Ole Bull, 3 inches 11 lines; in Thorwaldsen, 4 inches 3 lines).

Measurements of the middle head of females differed less from those of males than was seen in the case of the fore or hind part of the head; in general they indicated a more or less predominant sensibility. The comparison of the heads of the eminent German actresses, Schrœder, mother and daughter, was highly remarkable in this respect. The former, sedate, measured, and stately in her performances, had a middle head measuring 4 inches 10 lines in height, and 5 inches 1 line in breadth, with a hind head of 4 inches 4 lines in height; the latter, who was also a great singer of wonderful creative fancy, had a middle head of 5 inches in height and $5\frac{1}{2}$ inches in breadth, with a height of but 3 inches 11 lines for the hind head. A pair of female criminals, one a poisoner, the other a child murderer, exhibited a height of 4 inches 5–10 lines, with a common breadth of 5 inches 3 lines for the middle head. The height of the hind head in females was generally about 4 inches, never over 4 inches 4 lines, while in males it may amount to 4 inches 8 lines, thus corresponding to the greater weakness of the former sex.

With respect to the import of varying height and breadth in the cranial vertebræ, Carus came to the conclusion, that a greater breadth in the anterior cerebral mass, and in the sincipital vertebra, was connected with a greater tendency to a philosophical intellect. In the middle portion of the head, too, variations in height and breadth appear decidedly to run parallel with a more or less subjective direction of mind. In the occipital vertebra, if the height seems more to keep pace with the motive energies, the breadth is more in harmony with sexual characteristics.

In illustration of the above developments, *pl.* 120, *fig.* 3, represents a

cast of the head of Napoleon; *fig.* 4, that of Tiedge; *fig.* 5, of Kant; *fig.* 6, of Talleyrand; *fig.* 7 represents the skull of Schiller; *fig.* 8, that of a Greenlander; *fig.* 9, that of a suicide; *fig.* 10, that of a poisoner; *fig.* 11, that of a Cretin; *fig.* 12, that of an idiot; *fig.* 13, that of a brown sajou ape; *fig.* 14, that of a Grison ape.

4. Anatomy of the Nerves.

A. Cerebral Nerves.

1. Olfactory Nerves. First Pair. This pair of nerves is the first given off, arising from the inferior anterior surface of the brain. From the bulb which each of these nerves forms at the side of the crista galli, several branches descend into the nose through the foramina in the cribriform plate; they may be divided into the internal, middle, and external. The *internal branches*, about ten in number, descend in grooves along the septum, and subdivide into many filaments, which form a plexus with each other in the mucous membrane. The *middle branches* are distributed to the mucous membrane lining the roof of each nostril. The *external branches* descend along the groove, on the turbinated bones, dividing and communicating frequently with each other, so as to form numerous plexuses which are lost in the pituitary membrane.

2. Optic Nerves. Second Pair. This arises by a broad flattened root, one portion of which comes from the thalamus opticus, and another from the testis; advancing it adheres so closely to its fellow, that the two seem fused together, in such a way that there is no line of separation between them. This junction presents the form of the letter X, and is called the chiasma. Separating again after this union, each nerve passes through its optic foramen, and piercing the sclerotic and choroid membranes of the eye, expands to form the retina. This nerve is accompanied by the ophthalmic artery. The other nerves distributed to the eye are, the third nerve, the fourth, the ophthalmic branch of the fifth, and the sixth.

3. The Motores Oculi. Third Pair. This arises from the internal face of the crus cerebri, in advance of the anterior margin of the tuber annulare. After passing through the foramen lacerum orbitale, it divides into two branches, a superior and an inferior. The *superior* or *smaller* passing above the optic and nasal nerves, divides into two branches, one to the superior rectus, the other to the levator palpebræ. The *inferior* or the larger branch passes below and to the outside of the optic nerve, and divides into three branches: an *internal*, to the internal rectus; a *middle*, to the inferior rectus; and an *external*, to the inferior oblique.

4. The Trochleator Patheticus. Fourth Pair. This is the smallest nerve coming from the encephalon, not exceeding a sewing thread in thickness. It arises by two roots from the upper anterior face of the valve of the brain, just below the testes; passing through the foramen lacerum orbitale, it reaches the eye, and is distributed to the superior oblique muscle.

5. THE TRIGEMINI: TRIFACIAL. FIFTH PAIR. This emerges by three roots from the side of the pons Varolii, just where it is continuous with the crus cerebelli, and after forming the *semilunar* or *Gasserian ganglion*, is divided into three large branches, the ophthalmic, the superior, and the inferior maxillary.

The *ophthalmic* passes along the outer side of the cavernous sinus, and approaching the foramen lacerum orbitale, divides into three branches, the lachrymal, the frontal, and the nasal. The *lachrymal* is ultimately distributed to the conjunctiva and lachrymal gland. The *frontal* divides into an *internal* or *supra-trochleator* nerve, to the region of the eye, and the *external*, *supra-orbital*, or *proper frontal nerve*, to the scalp. Both the frontal and lachrymal are nerves of sensation. The *nasal nerve* divides into two branches, the *external* or *infra-trochleator* to the lachrymal passages and the region of the nose, and the *internal* or *proper nasal*.

The *superior maxillary nerve* is larger than the ophthalmic, and passes from the middle of the ganglion forwards through the foramen rotundum into the pterygo-maxillary fossa. Here it sends down two small branches, which ultimately unite in the *spheno-palatine ganglion* or the *ganglion of Meckel*. From this proceed three sets of branches, an inferior, internal, and posterior. The *inferior* or *palatine* nerves are distributed to the palate and uvula. The *internal branch*, or the *spheno-palatine nerve*, divides into several branches after passing into the upper and back part of the nose; the principal of these is the *naso-palatine nerve* or *nerve of Cotunnius*. The third or posterior branch of the ganglion is the *vidian* or *superior petrosal nerve*, distributed to the tympanic apparatus.

Other branches sent off by the superior maxillary are, the *orbital*, the *malar*, the *temporal*, the *posterior dental*, the *infra-orbital*, and the *anterior dental*, all of which indicate their distribution in their names.

The *inferior maxillary nerve* descends from the ganglion through the foramen ovale into the zygomatic fossa, where it divides into two large branches, a *superior* or *external*, and an *inferior* or *internal*. The former subdivides into the *two deep temporal*, the *masseteric*, the buccal and the pterygoid; the latter into the *auricular*, *inferior dental*, and *gustatory nerves;* most of these have various subdivisions.

6. MOTOR EXTERNUS OCULI. SIXTH PAIR. This arises from the base or upper portion of the corpus pyramidale, under the posterior margin of the tuber annulare, or pons; the fibres are assembled into two roots, of which the external is much the larger. These roots, uniting, pass through the sphenoidal foramen, and are distributed to the abductor oculi muscles.

7 *a*. FACIAL NERVE OR PORTIO DURA OF THE SEVENTH PAIR. This arises by two branches; the larger from the medulla oblongata, at the most superior part of the corpus restiforme; the smaller from that portion of the medulla oblongata placed between the first branch and the auditory nerve. The two branches are kept distinct for the distance of several lines, when they unite, and, passing into the meatus auditorius internus and through the aqueduct of Fallopius, emerge at the stylo-mastoid foramen, to be distributed upon the muscles and skin of the head. In the aqueduct of Fallopius it

sends off the *tympanic branch*, and lower down the *chorda tympani*. Escaping through the stylo-mastoid foramen, it gives off three branches, the *posterior auricular*, *stylo-hyoid*, and *submastoid* or *digastric*. Further branches and subdivisions are the *temporo-facial*, with its fasciculi, the temporal, malar, and buccal; and the *cervico-facial*, still further separated into maxillary, submaxillary, and cervical branches. The portio dura nerve has been supposed to be the exclusive motor nerve of all the superficial muscles of the face, of the eyelids, nose, mouth, lips, and of the ears.

7 *b*. The Auditory Nerve, or Portio Mollis of the Seventh Pair. This, which is a single nerve of sense, arises partly from the medullary striæ, or the surface of the calamus scriptorius, and partly from the corpus restiforme, between the glosso-pharyngeal nerve and the tuber annulare; it is distributed to the labyrinth of the ear.

8 *a*. Glosso-Pharyngeal, or First Branch of the Eighth Pair. This arises from the posterior cord of the medulla oblongata, just above and anterior to the superior filaments of the next nerve. Its filaments, therefore, spring from the anterior margin of the corpus restiforme, or from the fissure separating it from the corpus olivare. After the union of its filaments into a round cord, it passes through the foramen lacerum posterius, and is ultimately distributed to the tongue and pharynx.

8 *b*. The Pneumogastric Nerve, or Vagus of the Eighth Pair. This arises from the corpus restiforme of the medulla oblongata, posterior to the highest root of the accessory nerve. It passes through the foramen lacerum posterius, in a canal in common with the spinal accessory, and is separated posteriorly from the internal jugular vein by a small spine of bone. In the foramen it presents a ganglionic expansion, and below it a gangliform swelling, nearly an inch in length; the latter communicates beneath the base of the cranium, and in front of the two first cervical vertebræ, with the facial, glosso-pharyngeal, spinal accessory, sympathetic, and superior spinal nerves, constituting the *basilar plexus*. Descending towards these organs, it gives off cervical, thoracic, and abdominal branches. The *cervical* branches are the communicating, the auricular, the pharyngeal, the superior laryngeal, the cardiac, and the recurrent or inferior laryngeal. The *thoracic* gives off the pulmonary and the œsophageal nerves, the former presenting the anterior and posterior pulmonic plexus, the latter the œsophageal plexus. On the right stomach, the right vagus passes behind the cardiac orifice; and its branches, with some others, unite to form the cardiac plexus. The pneumogastric nerves supply the pharynx, œsophagus, and partly the stomach; also the larynx, trachea, lungs, and partly the heart; they are, therefore, concerned in deglutition, voice, respiration, circulation, and digestion, and maintain important sympathies between the different organs concerned in these functions.

8 *c*. The Nervus Accessorius, or Spinal Accessory. This is the third branch of the eighth pair. It arises from the posterior fasciculus of the medulla oblongata, just above the hypoglossus nerve, and also from the posterior fasciculus of the medulla spinalis; with a variable number of roots, it passes through the foramen lacerum posterius, to be distributed to

the muscles and integuments of the neck. This nerve is supposed to be compound, but essentially motor, and has been termed "the respiratory nerve of the neck."

9. The Lingual Nerve; Hypoglossal Nerve. Ninth Pair. This arises from the medulla oblongata, by several fasciculi, whose roots spring from the fissure which separates the corpus pyramidale from the corpus olivare; these unite into two or three trunks, which ultimately coalesce into one which passes through the anterior condyloid foramen of the occipital bone, to be distributed to the muscles of the tongue. As it passes across the neck, below the digastric tendon, it gives off a considerable branch, the *descendens colli* or *noni*, to the omo-hyoid, sterno-hyoid, and thyroid muscles.

Pl. 137, *fig.* 17, branches of the fifth pair: [5], infra-orbital; [6], frontal; [7], lachrymal; [8], buccal; [9], superficial temporal; [10], mental; [11], hypoglossus; [12], trunk of the facial nerve, exterior to the aqueduct of Fallopius. For the distribution of the facial nerve see *fig.* 18, near the third branch of the fifth pair. *Fig.* 18[1], stem of the fifth pair; [2], spheno-palatine ganglion; [3], superficial branch of the vidian nerve, its connexion with the sympathetic in the foramen lacerum, and with the facial nerve; [4], lingual branch of the fifth pair, and the union of the chorda tympani with it; [5], ganglion oticum, with its branches; [6], facial nerve; [7], union of the vidian nerve with the facial; [8], origin of the chorda tympani from the facial nerve; [9], union of the facial nerve with the glosso-pharyngeal; [10], with the vagus; [11], glosso-pharyngeal nerve with the ganglion petrosum, from which proceeds the plexus of Jacobson; [12], carotid plexus. *Fig.* 19, ophthalmic branch of the fifth pair: [1], skin of the forehead reflected; [2], optic nerve; [3] oculo-motor nerve; [4], sixth pair; [5], ophthalmic branch of the fifth pair; [6], lachrymal nerve; [7], its anastomoses with the fourth pair; [10], ethmoid nerve. *Fig.* 20, superior maxillary branch of the fifth pair: [2], lachrymal nerve; [2], second branch of the fifth pair; [3], spheno-palatine ganglion; [4], superficial branch of the vidian nerve; [5], deeper branch; [6], posterior dental nerve; [7], branch to the gums; [8], anterior dental nerve; [9], dental plexus; [10], infra-orbital nerve; [11], masseteric nerve; [12], superficial temporal; [13], inferior maxillary nerve, cut off; [14], lingual nerve, with its connexion with the chorda tympani; [14'] (beneath [16]), submaxillary ganglion; [15], glosso-pharyngeal; [15'], accessory of Willis; [16], vagus; [17], hypoglossus nerve, or ninth pair; [18], internal carotid artery. *Fig.* 21[1], inferior maxillary, within the foramen rotundum; [2], temporal nerve; [5], masseteric nerve; [6], superficial temporal nerve, and its connexion with the facial; [7], inferior dental; [8], mental; [9], lingual, with the chorda tympani; [10], internal pterygoid.

Pl. 138, *fig.* 9, inferior maxillary branch of the fifth pair, from outside: [1], masseteric; [2], buccal; [2'], its ramifications on the outside of the buccinator muscle; [3], external pterygoid; [4, 4], deep temporal nerves; [5], superficial temporal; [6], facial nerve; [7], dental nerve of the lower jaw. *Fig.* 10, fifth pair, from within: [1], distribution of the nerve of smell on the spongy bones; [2], trigemini nerve, Casserian ganglion, and origin of the three principal branches; [3], external or lateral nasal branch; [4], spheno-palatine ganglion;

[5,5,5], posterior nasal nerves; [6], palatine nerves; [7], lingual nerve and chorda tympani; [8], submaxillary nerve; [9], superficial temporal nerve; [10], inner pterygoid; [11], ganglion oticum; [12], threads from it to the tympanum, and to the mucous membrane of the nose; [13], connecting branch to the facial nerves; [14], threads to the tensor tympani; [15], threads to the plexus, along the internal maxillary artery; [16], facial nerve; [17], chorda tympani.

Pl. 138, *fig.* 11, nerves of the larynx: [1], superior, [2], inferior laryngeal nerves; [3], union of the two. *Fig.* 12 [1], laryngeal; [2], thyroid gland; [3], trachea; [4], arteria innominata; [5], right lung; [6], stomach; [7], great cœliac plexus; [8,9], glosso-pharyngeal nerve; [10], lingual branch of the fifth pair; [11], hypoglossus; [12], accessory nerve; [13], division into the muscular branch and into the branch to the tenth pair; [14], vagus; [15], its pharyngeal branch uniting with threads of the glosso-pharyngeus and sympatheticus to form the pharyngeal plexus; [16], superior laryngeal nerve and its division into an outer and an inner branch; [17,17,17], nerves of the heart; [18], off-shoot of the recurrens; [19], inferior cervical plexus of the sympatheticus; [20], tracheal branch; [21], pulmonic plexus; [22], pharyngeal nerves; [23], entrance of the right vagus into the cœliac plexus; [24], left trunk, and its distribution on the stomach; [25], cœliac plexus.

B. Spinal Nerves.

There are thirty-one pairs of spinal nerves, each arising by two roots, an anterior or motor root, and a posterior or sensitive root.

The anterior roots proceed from a narrow white line, anterior lateral sulcus, on the antero-lateral column of the spinal cord, and gradually approach towards the anterior longitudinal fissure as they ascend. The posterior roots proceed from the posterior lateral sulcus, a narrow grey stria, formed by the internal grey substance of the cord.

After the formation of a ganglion the two roots unite and constitute a spinal nerve. The spinal nerves are divided into cervical, dorsal, lumbar, and sacral. The cervical nerves pass off transversely from the spinal cord; the dorsal are oblique in their direction, and the lumbar and sacral vertical; the latter form the large assemblage of nerves at the termination of the cord called *cauda equina*.

1. The Cervical Nerves are eight in number, increasing in size as they descend; the first passes out above the atlas, and is named the sub-occipital; the eighth passes out above the first dorsal vertebra. All of these, except the first and second, immediately outside the intervertebral foramina, divide into a posterior and an anterior branch; the posterior of each is generally the smaller. The anterior branches of the first four form the cervical plexus, and those of the last four with the first dorsal, the brachial plexus.

2. The Cervical Plexus is formed by the loops and communications between the anterior branches of the four superior cervical nerves, which join each other in arches, from the convexities of which branches arise that again join in a similar manner: lymphatic glands and a quantity of cellular tissue are entangled in the areolæ between these. This plexus commu-

nicates with the superior cervical ganglion of the sympathetic above, and with the continued cord of this nerve lower down; also with the pneumogastric, lingual, and spinal accessory. Besides numerous muscular filaments, it sends off various cutaneous branches, which are either ascending or descending.

The ascending branches are: *a. Superficialis colli*, arising about the middle of the neck, and distributed on the anterior and lateral region of the neck. *b. The auricularis magnus* arises in the same situation and ascends nearly parallel and posterior to it; at the parotid gland it divides into two branches, one superficial, the other deep, which supply the external ear and sides of the scalp. *c. The occipitalis minor* arises near the last from the second cervical nerve, and ascending is distributed to the skin and occipito-frontalis muscle.

The descending branches are superficial and deep. The superficial branches, or *supra-clavicular*, are long and rather large; they arise from the third and fourth cervical nerves, and pass to muscles of the neck and shoulder. The deep descending branches are: *a.* The *muscular.* These arise from different parts of the plexus, and are principally distributed to the trapezius, levator anguli scapularis, and sterno-mastoid muscles. *b.* The *communicating branches* are very numerous. From the second and third roots of the plexus descends the *communicans noni* to the hyoid apparatus *c.* The most important branch of the cervical plexus is the *internal respiratory* or *phrenic nerve.* This arises from the lower part of the plexus, and descending on the anterior scalenus muscle, enters the thorax between the subclavian vein and artery; passing down the middle mediastinum to the diaphragm on the side of the pericardium, the left phrenic takes an oblique course round the base of the heart.

Pl. 137, *fig.* 15, superficial nerves of the cervical plexus: [1], superficial temporal nerve of the fifth pair; [2], occipitalis magnus; [3], superior cutaneous cervical nerve, from the facial; [4], auricularis magnus; [5], occipitalis minor; [6], an inconstant occipital nerve, [7, 7], some posterior cutaneous branches; [8], accessory nerve; [9], supra-scapular nerve; [10], supra-clavicular nerve; [11], middle cutaneous cervical nerve; [12], a small branch accompanying the jugular vein; [13], connexion of the cervical plexus with the facial nerve.

The anterior divisions of the last four cervical, and that of the first dorsal, unite to form the brachial plexus.

3. The Brachial Plexus. This plexus is broad and flat, the nerves forming it being very large, particularly the inferior. It is situated at the lower and lateral parts of the neck, between the scalenic muscles and the subclavian artery; it then passes under the clavicle into the axilla, where it rests on the serratus magnus, ending opposite to the coracoid process. The numerous branches of this plexus may be arranged into two orders, one (*supra-clavicular*) arising above the clavicle, the other (*axillary*) arising from below this bone.

The *supra-clavicular* branches are as follows: 1. For the subclavian muscle. 2. Small branches from the upper root of the plexus to the scaleni, levator anguli, and rhomboidei muscles. 3. *Posterior thoracic* or

external respiratory, from the fifth and sixth cervical. It descends obliquely outwards behind the brachial plexus, and passing along the serratus magnus, supplies it with fasciculi. 4. *The supra-scapular* form the upper division of the plexus. Descending it gives off branches to the supra-spinatus, infra-spinatus, teres minor, and to the shoulder-joint.

The *infra-clavicular*, or *axillary branches*, are the *thoracic*, the *sub-scapular*, and the *circumflex*, to the pectoral muscles, the axilla, and the shoulder; the *internal cutaneous*, *external* or *musculo-cutaneous*, *median* or *brachial*, and the *ulnar*, to the anterior and internal aspect of the arm, forearm, hand, and fingers; the *musculo-spiral*, or *radial nerve*, to the supinators of the forearm, hand, and fingers. Some of these branches we shall now notice more in detail.

The *median* or *brachial nerve* is the largest branch of the plexus; it generally arises by two roots, one in common with the external cutaneous, from the upper part of the plexus, the other internal, from the lower end of the plexus in common with the ulnar and internal cutaneous. The brachial artery usually separates these two roots, which soon unite into one thick cord, passing down superficially as far as the bend of the elbow; at the end of the elbow it passes along the brachialis anticus, and perforating the pronator, descends along the middle of the forearm, and terminates in the hand by five or six branches. A little below the elbow this nerve gives off the *anterior interosseal nerve.*

The *ulnar nerve* arises from the lower part of the plexus in common with the internal cutaneous and the inner head of the median; descending the arm, it passes behind the elbow-joint through the groove between the inner condyle and the olecranon process; it then passes forwards and descends along the ulnar side of the forearm to the carpus, and passing over the annular ligament close to the pisiform bone, ends in the palm of the hand in two branches, a superficial and a deep. A little above the wrist it gives off the *dorsalis carpi ulnaris*, a large branch which winds round the ulna to the back of the hand, there dividing into several long branches.

Connected to the digital and other sensitive branches both of the median and ulnar nerves are a number of small indurated white bodies, now known by the name of Pacinian corpuscles from their discoverer. They appear like globules of firm cellular membrane, in size from $\frac{1}{20}$ of an inch upwards, and connected to the nerve by a short delicate nervous stem. The corpuscle itself is found to consist of a great number of concentric membranous capsules, with intervening clear fluid. Their function is unknown. Pacini suggested that they might in some way be connected with the phenomena of animal magnetism; others see in them an analogy to the electrical organ of fishes. They are especially abundant in the mesentery and mesocolon of the cat. Similar sessile bodies have recently been discovered by Leidy in the intercostal nerves of the boa constrictor.

The *musculo-spiral* or *radial nerve* is the largest branch in the plexus; it proceeds from the middle and lower divisions in common with the circumflex nerve, and descending to the elbow there divides into two branches, an anterior or radial branch and a posterior or interosseal branch, previously

to which it sends off various muscular and cutaneous branches. The anterior or radial nerve supplies the supinator longus muscle, along which it descends, and passing behind its tendon about the middle of the forearm, becomes cutaneous; continuing in its decent, it divides into two considerable branches on the back of the head. The *deep branch*, or the *posterior interosseal nerve*, is larger than the radical; winding around the upper part of the radius, it descends along the back part of the forearm, and divides into several branches, superficial and deep, which supply the two layers of extensor muscles.

Pl. 137, *fig.* 16 (see *fig.* 15, for the four superior cervical nerves), deep cervical nerves; brachial plexus: [1], facial nerve; [2], vagus; [3], internal carotid artery; [4], accessory nerve; [5], its connexion with the cervical nerves; [6], hypoglossus; [7], anterior branch of the first cervical nerve, uniting with the hypoglossus and vagus; [8], connecting branches of the second and third cervical nerves with the hypoglossus; [9], phrenic nerve; [10], [10], deep branches of the cervical plexus; [11], brachial plexus; [12], the nerve for the subclavian muscle giving off a branch to the phrenic nerve; [13], anterior thoracic nerve; [14], posterior do.; [15], [16], [17], branches of the subscapular nerve, to the subscapularis, the latissimus dorsi, and teres muscles; [18], axillary artery, embraced by the brachial plexus; [19], brachial branches of the brachial plexus.

Pl. 138, *fig.* 1, cutaneous nerves of the arm, on the dorsal side: [1], cutaneous branches from the axillary nerve; [2], [2], from the radial nerve; [3], [3], branches of the internal cutaneous; [4], [4], branches of the external cutaneous; [5], union of one of these branches with the radial nerve; [6], dorsal branch of the ulnar nerve with its digital branches; [7], dorsal branch of the radial nerve and its digital branches; [8], connecting branches between the radial and ulnar nerves; [9], bifurcation of a digital nerve. *Fig.* 5, [1], trapezius muscle; [2], rhomboideus do.; [3], accessory nerve; [4], [4], deep posterior branches from the cervical and brachial plexus; [5], supra-scapula nerve; [6], axillary nerve or circumflex nerve of the arm.

The share of the brachial plexus possessed by each nerve of the superior extremities in the brachial plexus may be expressed as follows, the figures referring to the 5th, 6th, 7th, and 8th cervical nerves, and to the 1st dorsal nerves, which together constitute this plexus.

The supra-scapular nerve, 5, 6, or 5, 6, 7.

The subscapular nerve, 5, 6, 7, 8, or 5, 6, 7.

The anterior thoracic, 5, 6; the posterior often 8, 1.

The great internal cutaneous nerve of the arm, 8, 1, or 7, 8, 1, or 1.

The musculo-cutaneous nerve, 5, 6, 7, or 5, 6, or 5, 7.

The axilliary nerve, 5, 6, 7, or 5, 6, or 5, 6, 7, 8, 1.

The radial nerve, 5, 6, 7, 8, or 5, 6, 7, 8, 1, or 6, 7, 8, or 6, 7, 8, 1, or 5, 6, 7, or 7, 8.

The ulnar nerve, 5, 6, 7, 8, 1 or 5, 6, 7, 8, or 6, 7, 8, 1, or 6, 7, 8, or 7, 8, 1, or 8, 1.

The median nerve, 5, 6, 7, 8, 1, or 5, 6, 7, 8, or 5, 7, 8, 1, or 6, 7, 8, 1, or 5, 6 , 7, 1, or 8, 1.

The posterior thoracic, 5, 6, 7, 1.

Pl. 138, *fig.* 4, brachial plexus unravelled: [1, 2], fifth and sixth cervical nerves; [3], branch arising from the union of the two and dividing into [4], the musculo-cutaneous nerve, and [5], a connecting branch of the median nerve; [6, 7], eighth cervical and first dorsal nerve; [8], their connexion, and [9], their division into a branch going to the median nerve, the ulnar nerve [10], and the internal cutaneous nerve [11]; [12], small internal cutaneous nerve; [13], median nerve; [14, 14], radial nerve; [15], posterior thoracic. *Fig.* 6, relations of the digital nerves or the palmar side: [1, 1], digital nerves; [2], plexus at the tip of the finger formed by the union of the two. *Fig.* 7, relations of the digital nerves or the dorsal surface: [1, 1], dorsal nerves; [2, 2], branch of the preceding nerves passing round to the dorsal surface.

4. The Dorsal Nerves are twelve in number on each side. The first pair passes between the two first dorsal vertebræ, the last pair between the last dorsal and first lumbar vertebræ; the first is very large, the following diminish in size, but the two last again increase, and the twelfth is nearly equal to the first. These nerves are distributed to the parietes of the thorax and abdomen, also to the muscles and integuments on the posterior and lateral regions of the trunk; they are not connected together in any plexus like the cervical, lumbar, and sacral nerves, but are distributed separately. All their anterior branches, however, are united through the medium of the chain of the dorsal sympathetic ganglions, each of the former being connected by one or two filaments to one of the latter; the first dorsal also joins to the last cervical in the brachial plexus, and the last dorsal is connected to the first lumbar; they all divide into a posterior and an anterior or intercostal branch. The posterior or dorsal branches are smaller than the anterior; they each pass backwards, accompanied by the posterior branch of the intercostal artery, through a foramen formed above and below by the spinous processes, internally by the bodies of two vertebræ, and externally by the anterior or great costo-transverse ligament; they supply the muscles and integuments of the back and loins.

The anterior dorsal nerves, excepting the first, are named the intercostals, and pass round the parietes of the thorax between the laminæ of the intercostal muscles, and inferior to the intercostal blood-vessels: the superior five or six are confined to the chest, and extend as far as the sternum; the anterior portions of the inferior five or six are placed in parallel lines between the abdominal muscles, and extend to the rectus. They supply the parietes, muscles, and integuments of the thorax and of the upper part of the abdomen.

5. The Lumbar Nerves. There are five pairs. They are larger than the dorsal, and increase in size downwards; the first escapes between the two first lumbar vertebræ, the fifth between the last vertebræ and the sacrum; like the dorsal, they divide into posterior and anterior branches. The posterior pass between the transverse processes to the lumbo-spinal muscles, and each divides close to the multifidus spinæ into an internal and external branch; the former is lost in the multifidus spinæ, inter-spinous, and inter-transverse muscles; the external branch is large and musculo-cutaneous, supplying the sacro-lumbalis and lumbar aponeurosis. The two

last posterior nerves are very small, and are distributed to the integuments of the glutæal region.

The anterior branches of the lumbar nerves are much larger than the posterior, and increase in size as they descend. In the psoas magnus muscle they unite with each other into a plexus.

6. The Lumbar Plexus is long and somewhat triangular, situated along the sides of the lumbar vertebræ, in front of their transverse processes, and near the posterior surface of the psoas magnus muscle; in addition to its three principal and terminal branches, the anterior crural, the obturator, and the lumbo-sacral, it gives off some long superficial branches.

The *superficial branches* of the lumbar plexus supply the inferior portion of the abdominal muscles and integuments, the integuments of the groin, of the upper and outer part of the thigh, and also those of the inguinal and pubic regions. The principal of these are the *superior musculo-cutaneous* (external ilio-inguinal, ilio-hypogastric, ilio-scrotal), the *middle musculo-* or *inguino-cutaneous*, the *inferior musculo-cutaneous* or *external cutaneous*, and the *genito-crural.*

The *anterior crural nerve* arises in the lumbar plexus from the four superior nerves, principally from the third and fourth; it is destined to supply the integuments on the anterior and inner sides of the lower extremities, also extensors of the leg, and the principal flexors of the thigh or hip-joint. It subdivides into a superficial and a deep fasciculus. The principal branches of the superficial division are, the *middle cutaneous*, the *internal cutaneous*, the *vaginal branches* to the sheaths of the vessels, and the *long saphena.* The branches of the deep division are wholly muscular.

The *obturator nerve* arises chiefly from the third and fourth lumbar, perforates the psoas muscle, and descends obliquely inwards to the inside of the thigh, where it descends into two branches, an anterior and a posterior. The anterior or superficial branches are lost in the graciles, adductor brevis, pectinæus, and vastus externus. The posterior or deep branches supply the obturator externus and adductor magnus; one long branch extends to the back part of the knee joint.

The *lumbo-sacral nerve* is the largest branch of the lumbar plexus; it is formed by a large portion of the anterior division of the fourth, and the whole of that of the fifth lumbar nerves; enters the pelvis, and behind the iliac vessels divides into two branches. Of these, the *communicating* is inferior or anterior, and joins the first anterior sacral nerve, forming part of the sacral plexus; the other, posterior and superior, is the *great* or *superior glutæal nerve.* This has various muscular branches for the muscles of the thigh.

7. The Sacral Nerves are six pairs. They form their ganglions, and divide within the spinal cord into anterior and posterior branches. The *posterior sacral nerves* are very small, pass through the posterior sacral foramen, and supply the muscles and integuments of the sacral and glutæal regions.

The *anterior sacral nerves* are very large, especially the three superior; the three last are much smaller, and the sixth is very minute, and sometimes

wanting. The four superior, with the branch from the last lumbar, form the *sacral plexus*, placed on the sacrum behind the pelvic fasciæ; its form is somewhat triangular or palmate. Each of the sacral nerves, immediately after its emergence from the foramen, is joined by a short branch from one of the ganglions of the sympathetic. The sacral plexus sends off the following branches, both internally and externally: the internal or pelvic are the *hæmorrhoidal*, *vesical*, and *muscular*, and in the female the *uterine* and the *vaginal;* the external branches are the *inferior* or *lesser sciatic*, the *inferior glutæal*, *posterior cutaneous*, *pudic*, and *great sciatic* or *posterior crural.* All these escape by the lower part of the great sciatic notch below the pyriform muscle. The *visceral branches* arise from the fourth and fifth sacral, and are directed forwards into the cavity, there to be joined by numerous filaments from the sympathetic nerve, forming the *hypogastric plexus*, a complex network of nervous filaments entangled around the branches of the internal iliac artery, and accompanying them to their terminations.

The *internal* or *pelvic muscular branches* supply the levator ani, obturator internus, pyriformis, and sphincter ani. The *lesser sciatic*, *inferior glutæal*, and *posterior cutaneous nerves*, may all be regarded as one large, loose, and flat fasciculus, escaping from the pelvis below the pyriform muscle; branches are distributed to the perinæal regions, and to the upper part of the leg.

The *pubic nerve* arises from the third and fourth sacral, and, passing through the great sciatic notch or foramen, re-enters the pelvis by the lesser sciatic notch, and proceeds towards the pubes; it then divides into two branches, an inferior and a posterior. The inferior or *perinæal nerve*, the larger of the two, is distributed to the muscles and integuments of the perinæum. The superior branch continues along the pubes to the symphyis, and is finally distributed to the subcutaneous cellular tissue of the glans penis.

The *great sciatic*, or *posterior crural nerve*, is the principal branch of the sacral plexus, and the largest nerve in the body. It proceeds from the four superior sacral nerves, forms a flat broad band, which escapes from the pelvis below the pyriform muscle, and descends close to the outer side of the tuber ischii, along the back part of the thigh, as far as the ham, where it divides into the external and internal poplitæal nerves, having given off numerous muscular and cutaneous branches. About the middle of the thigh it often gives off a large nerve, the *external articular*, to the outer side of the knee joint.

The *external poplitæal*, or the *peronæal nerve*, is destined to supply the muscles on the external and anterior aspect of the leg, as also the integuments of the leg and dorsum of the foot. Descending, it gives off several long branches, termed the *external cutaneous nerves of the leg;* one of these, the *communicans peronæi*, passes backwards over the outer part of the gastrocnemius, and communicates with the external saphenous nerve. Passing round the joint of the fibula, the peronæal nerve divides into two branches, the musculo-cutaneous and the anterior tibial. The *musculo-cutaneous* passes down the leg, and a little above the external malleolus, divides into the internal and external tarsal nerves, or the *dorsal nerves of the foot.* The *an-*

terior tibial, or *interosseal nerve*, supplies muscles of the leg, and on the tarsus divides into an external and internal branch, the latter of which, the continued trunk, passes to the first and second toes.

The *internal poplitæal* or *posterior tibial nerve*, is much larger than the preceding, being destined to supply the large muscles on the back of the leg, and the muscles and integuments of the sole of the foot. In the ham it gives off various articular branches, and one principal cutaneous branch, the *external saphenous.* Continued down the leg, the posterior tibial nerve, at the tendo Achillis, gives off several large branches, as the *external* and *internal plantar* to the lower surface of the foot.

Pl. 138, *fig.* 2, crural nerve, and its distribution: [1], crural vein; [2], crural artery; [3], crural nerve; [4], external cutaneous nerve; [5], branches embracing the vessels; [6], saphena; [7, 7], saphenous nerve; [8], cutaneous branch from the peronæal nerve to the foot. *Fig.* 3, nerves of the sole of the foot: [1], division of the posterior tibial nerve into [2], the inner, and [3], the outer plantar nerve; [4], division of the inner plantar nerve into four digital nerves; [5], division of the outer into a superficial and a deep branch.

C. Sympathetic System.

In addition to the five small ganglions on each side, already noticed in the description of the cerebral nerves, viz. the Casserian, the lenticular or ophthalmic, the spheno-palatine or Meckel's, the sub-maxillary, the otic or the ganglion of Arnold: also, the several ganglions on the posterior roots of the spinal nerves: we find one continued chain of these bodies placed along the vertebral column, on either side of the median line, and at regular intervals. These ganglions, on each side, are all connected to each other, and resemble a knotted cord; these cords receive the name of the sympathetic nerves.

The *sympathetic nerves*, therefore, are two in number: they descend from the base of the cranium perpendicularly along the neck, and are placed anterior to the vertebræ, on the rectus capitis and longus colli muscles, and behind the great vessels and nerves. At the upper end of the chest, each of these nerves is divided by the subclavian artery into several branches, which encircle that vessel, and unite below it in the thorax. Through this cavity they descend, at first obliquely, backwards, and outwards, along the side of the spine, over the heads of the ribs and their stellate ligaments, and are covered by the pleura; they then incline a little forwards, and pass behind the true ligamentum arcuatum into the abdomen; through this region they descend obliquely outwards on the fore part of the lumbar vertebræ, between the psoas muscles and the crura of the diaphragm; they then sink into the pelvis, keeping close to the sacrum, and descend along the anterior surface of this bone obliquely inwards; near its inferior extremity, or on the first part of the coccyx, they unite and terminate in a small ganglion, named coccygeal, or impar. The superior extremity of each sympathetic nerve is connected by several filaments with several of the cerebral nerves. Some of these connexions, particularly that with the sixth, have been improperly termed the origin of the sympathetic; at the base of the cranium it

communicates, either directly or indirectly, with the seventh, eighth, and ninth; in the cavernous sinus and orbital plexus with the third, fourth, fifth, and sixth; and even with the olfactory, optic, and auditory, by the fine filaments which accompany the nutrient arteries of those several organs in which these nerves expand and terminate; it also communicates, as has been already noticed, with the several ganglions in the head. In their course along the spinal column, each nerve regularly communicates with every pair of the spinal nerves, with each of the carvical nerves by one and sometimes by two filaments, and with each of the dorsal, lumbar, and sacral nerves by two, so that these nerves may be said to communicate with every nerve in the cerebro-spinal system. The sympathetic nerves have been considered by some as independent nervous systems, communicating by numerous branches with every portion of the cerebro-spinal system; by others they are regarded as nervous cords, formed by the union of branches from all the spinal and from several of the cerebral nerves: the latter is probably the more correct view.

Although perfect symmetry does not exist between these nerves on the right and left sides, yet the differences are but trifling. The sympathetic nerves send off numerous branches, which are chiefly destined to supply the heart and the coats of the great vessels, and all the pelvic and abdominal viscera, except the stomach. These branches arise from the ganglions on these nerves; of these there are generally three in the neck; in the back and loins they correspond with the number of vertebræ in those regions, and in the pelvis there are three on each side, and the coccygeal or impar ganglion below.

The cervical ganglions are three, the superior, middle, and inferior. Sometimes, however, there are four, and at others only two.

The *superior cervical ganglion* is of an oval figure and reddish color, extending from the first to the third cervical vertebra; its upper end is very small, and about half an inch beneath the carotid foramen in the petrous bone. It sends off several branches, superior, inferior, internal, external, and anterior. The *superior branches* are two in number; they ascend in the carotid canal to the cavernous sinus, and communicate with the sixth and the vidian branch of the fifth. In the carotid canal they form the *internal carotid plexus*, from which some filaments pass through the petrous bone into the tympanum. In this sinus, the ascending small filaments again form a plexus named *cavernous plexus*. From this plexus, filaments pass to the Casserian ganglion, others to the orbital plexus and lenticular ganglion, and the remainder accompany the artery to the brain. The *inferior* or *descending branch* is the continued cord of the sympathetic itself which joins the middle or cervical ganglion. The *anterior branches* are numerous; some communicate with the eighth and ninth in the great basilar plexus, others surround the external carotid, and divide into fasciculi which accompany all its branches and form loops and plexuses around each, named from their destination, thyroid, lingual, &c. The *external branches* join the superior cervical nerve; they are large and ganglionic. Some join the nervous loop, the principal unite with the second cervical

and others with the third and fourth. The *internal branches* are pharyngeal, laryngeal, and cardiac. The *pharyngeal* arise from the superior part of the ganglion; are of a pale red color and ganglionic structure; they pass inwards and join the pharyngeal branches of the glosso-pharyngeal and pneumogastric in the extensive plexus which supplies the pharynx and fauces. The *laryngeal* branches arise near the last, pass downwards and inwards, and join the branches of the superior laryngeal nerve. The *superior cardiac*, or superficialis cordis, arises near the lower part of the ganglion, and descending, enters the chest, and joins the great cardiac ganglion.

The *middle cervical ganglion*, smaller than the superior, is sometimes wanting. It is situated behind the carotid opposite to the fifth vertebra; from its anterior aspect it sends off the *middle* or *great cardiac nerve*, which enters the chest, and with the superior and inferior cardiac nerves joins the cardiac plexus and ganglion.

The *inferior cervical ganglion* is of an irregular figure, semilunar or triangular, and frequently appears to consist of several small ganglions connected with each other by reddish filaments. It is situated between the transverse process of the last cervical vertebra and the neck of the first rib; filaments from it communicate with the phrenic nerve and with the brachial plexus; its external branches join the three last cervical and first dorsal nerves. From its inferior aspect proceed the *inferior cardiac* nerves, which communicate with the middle, and with branches form the vagus and recurrens, ending in the cardiac plexus.

Cardiac Nerves, Ganglion, and Plexus. The *superior cardiac nerve* arises from the inner part of the superior cervical ganglion, and descends to the chest communicating with various nerves, and ultimately joining the cardiac plexus, the recurrens, and other nerves. The *middle cardiac nerve* arises from the middle cervical ganglion, or from the sympathetic nerve about the middle of the neck; it descends either in a single cord or in several parallel filaments into the thorax, where it is joined by large branches from the vagus and recurrens nerves; continuing its descent it terminates in the cardiac ganglion or plexus. The *inferior cardiac nerve* or nerves proceed from the inferior cervical ganglion, and terminate either on the fore part of the aortic arch, or in the anterior cardiac plexus.

The *cardiac ganglion* is situated within the arch of the aorta; it is joined by the right and left superior cardiac nerves, and by branches from the pneumogastric.

The *great cardiac plexus* is situated behind the ascending aorta, and consists of a plexus of nerves formed by the middle and inferior nerves from opposite sides, also by branches from the eighth pair, and the recurrent nerves. The roots of the large vessels and the structure of the heart are supplied by the branches from the great cardiac ganglion and plexus, and from the cardiac nerves. These branches form two smaller plexuses, the *anterior cardiac* or *coronary*, and the *posterior plexus.*

In the thorax the sympathetic nerves have twelve ganglions on each side of the spine; sometimes but eleven, when the last cervical and first dorsal are united into one. Each of the thoracic ganglions is small, flat, and tri-

angular, the base towards the spine, the apex external, covered by the pleura and a thin fascia. All communicate by their external branches with the anterior or intercostal branches of the spinal nerves. From the base or anterior edge of each ganglion, arise the internal branches, the mediastinal, and the great and lesser splanchnic.

The *great splanchnic nerve* arises by four or five distinct roots from the sixth, seventh, eighth, ninth, and tenth ganglions; they descend forwards and unite into a long, flat cord which enters the abdomen, where each nerve expands into the semilunar ganglion. The real origin of this nerve is from the cerebro-spinal system.

The *lesser splanchnic nerve* arises by two roots from the tenth and eleventh ganglions, which unite on the side of the last dorsal vertebra. The small nerve thus constituted enters the abdomen through the crus of the diaphragm, and then ends in the renal plexus.

The *semilunar ganglion* of each side is situated on the diaphragm, and partly on the aorta, on either side of the cœliac axis, and above and behind the supra-renal capsule. These are the largest ganglions on the sympathetic; though called semi-lunar, their form is very variable and irregular, and frequently instead of a single mass they consist of a congeries of knotted ganglions on the nervous cord; the right and left communicate with each other by several filaments, on which again small ganglions are placed. This communication surrounds the cœliac axis, and, as branches radiate from it in all directions, it is termed the *solar plexus.* This plexus is situated in the epigastrium, behind the stomach, in front of the aorta, and above the pancreas. In this plexus there are also some filaments from the lesser splanchnic and phrenic nerves, and the right vagus terminates in it; it is the most highly developed portion of the sympathetics, and has been regarded as the head or centre of the great organic nervous system by some, who maintain the independence of the ganglionic system and its distinctness from the cerebro-spinal nerves. From it numerous nerves pass off in various directions; these nerves accompany the blood-vessels, and form plexuses around each, which are named, according to their destination, *hepatic*, *splanchnic*, *gastric*, &c.

1. The *phrenic plexuses* consist of branches arising on each side from the upper part of the solar plexus, accompany the phrenic arteries, and enter the diaphragm beneath the peritonæum; some branches follow the phrenic vessels, others pass in different directions, and join some minute filaments from the phrenic nerves of the cervical plexus.

2. The *supra-renal plexuses* arise partly from the last, and, by some delicate filaments from the semilunar ganglion of each side, they twine around the arteries which conduct them into the supra-renal bodies.

3. The *coronary* or *gastric plexus.* This fasciculus arises from the upper and anterior part of the solar and from the right vagus, and accompanies the arteria coronaria ventriculi, along the lesser curvature of the stomach, to the lesser omentum; its filaments are lost in the submucous tissue, and communicate with those of the right and left vagi.

4. The *hepatic plexus* is a very large fasciculus, arising partly from the

solar and partly from the semilunar ganglions; its large posterior filaments accompany the vena porta, and its anterior the hepatic artery; these nerves accompany the vessels in the lesser omentum to the liver: some are very large and distinct; they enter the transverse fissure, and ramify along with the vessels through the capsule of Glisson. While in the lesser omentum, they send long filaments to form the right gastro-epiploic plexus, along the great border of the stomach; others, also, along the cystic artery to the gall bladder.

5. The *splenic plexus* proceeds in a similar manner around the splenic artery; it is not so large as the hepatic; it sends many filaments to the pancreas, to the great end of the stomach, and along the left epiploic artery to its great curvature; the remaining few filaments enter the spleen.

6. The *superior mesenteric plexus* is a very broad and thick fasciculus continued from the lower border of the solar; it forms a complete sheath for the superior mesenteric artery; its branches are numerous, very long, and distinct; they accompany the arteries, but are straight, and do not form the same number of arches as the vessels are remarkable for: near the intestine many of them usually unite in an arch, from which fine filaments enter the tissues of the intestine. This plexus supplies all the small intestines, the cœcum, ascending colon, and right portion of its transverse arch.

7. The *renal plexuses* are formed by branches from each side of the solar, joined by the lesser splanchnic nerves; they surround the renal arteries, and accompany them into the kidneys. In the male, each renal plexus gives off a fasciculus to accompany the spermatic artery, around which it forms the *spermatic plexus*, and descends to the testis: in its course along the psoas muscle it gives off filaments to the ureter. In the female, corresponding branches from the renal plexuses supply each ovary.

8. The *inferior mesenteric plexus* is much smaller than the superior, from the root of which it is principally derived, being also joined by branches from the lumbar ganglions of the sympathetic: it accompanies the inferior mesenteric artery and its branches, and supplies the left portion of the arch, the descending and the sigmoid flexure of the colon.

9. The *hæmorrhoidal plexus* is formed by the filaments of the inferior mesenteric, continued around the superior hæmorrhoidal arteries, joined by small branches from the lower lumbar ganglions; it supplies the superior and middle portions of the rectum, and communicates with the hypogastric plexus.

From the sympathetic cords in the thorax a small branch is continued obliquely downwards and forwards on each side, close to the spine, and behind the crus of the diaphragm, to join the first lumbar or abdominal ganglion. This branch is seldom absent; when it is, the inferior splanchnic nerve, after joining the renal plexus, enters this ganglion, so that the continuity is always maintained between the thoracic and abdominal portions of the sympathetic nerves. The *lumbar ganglions* and their connecting thread are placed on the anterior aspect of the lumbar vertebræ, in a tendinous groove, between the crus of the diaphragm and psoas magnus of either side, nearer the median line above, but diverging below; they are variable

in number, usually four, and sometimes only three, and often one is prolongated into another. The *external branches* of each are two, *communicating;* they accompany the lumbar arteries, beneath the psoas muscle, close to the grooves on the sides of the vertebræ, and join the anterior lumbar nerves in the intervertebral foramina; they are white and distinct, and may be regarded as the lumbar roots of the sympathetic. These branches frequently have ganglions upon them, and they often unite with filaments from the lumbar plexus.

The *anterior* and *internal branches* are aortic and splanchnic. The aortic branches are numerous; they pass forwards in front of the aorta; the nerves of opposite sides unite, and are joined by branches from the solar plexus, and form a plexus, *lumbo-aortic.* This surrounds the aorta between the superior and inferior mesenteric arteries; small arteries and lymphatic glands and vessels are entangled in it; some of its branches join the inferior mesenteric plexus; inferiorly it divides into three portions; the middle enters the pelvis, and joins the hypogastric plexus; the lateral accompany the common iliac arteries to their division, and several filaments are prolonged around the internal and external iliac vessels. The *splanchnic branches* pass forwards from each ganglion, and join the several abdominal plexuses already mentioned.

The *hypogastric plexus* is of considerable extent; it is formed by the continuation of the lumbo-aortic plexus, joined by filaments from the lumbar ganglions; is situated in front of the base of the sacrum, between the common iliac arteries, and divides into a *right* and *left hypogastric plexus;* each of these is joined by branches from the sacral ganglions and anterior sacral spinal nerves; each plexus sends off numerous branches, which again form secondary plexuses on the organs to which they are distributed. Thus we have hæmorrhoidal, vesical, prostatic, vesicular, ovarian, and uterine plexuses. All these plexuses contain filaments from the sacral nerves, as well as from the sympathetic, and all are conducted to their terminations by the arteries of each organ.

As the sympathetic cords descend obliquely inwards, over the base of the sacrum, behind the iliac vessels, they are extremely small; in the pelvis, they at first increase in size, descend converging, and each ends in a minute thread; they are placed near the inner margin of the anterior sacral foramina. The *sacral ganglions* are four or five in number, of an oval or round form; their *external branches* join the anterior sacral nerves; their *internal branches* join the hypogastric, or some of their secondary plexuses. From the last ganglion a small branch arches across to meet a similar one from the opposite side: on this a small ganglion (*impar*) is occasionally to be found; if absent, a connecting plexus occupies its place; the terminal filaments are very minute, and distributed to the fore part of the os coccyx.

Although the sympathetic nerves and their branches appear to differ in structure from the cerebro-spinal nerves, yet they are essentially the same; the fibres seldom appear so white, but have rather a greyish-red color. The general neurilemma of each nerve is more dense, and therefore the internal fibrous or fasciculated texture is not so obvious; but if the former

be carefully divided, the latter will be found equally apparent. The great distinction depends on the occurrence of numerous ganglions, both on the principal cords as well as on their branches; each ganglion is invested with a firm capsule, which is continuous with the sheath of the afferent and efferent nerves. This capsule is surrounded by areolar tissue and blood-vessels; the latter ramify on and pierce the capsule; the internal surface of the latter is vascular, and may, on the larger ganglions, be separated as a vascular membrane from the external fibrous layer, and is analogous to the pia mater on the cerebro-spinal axis. The mass of a ganglion is composed of a plexus of nervous filaments, with a variable quantity of vesicular or grey neurine: the afferent nerves divide into numerous fibrillæ, which pass in the most varied directions, and re-unite most probably in different combinations, the interstices being filled with capillary vessels and grey neurine. Whether the efferent nerves consist of those filaments only which composed the afferent, or whether additional fibres are added to these in the ganglion, it is, in the present state of our knowledge, difficult if not impossible to determine. The only material difference to be observed between the structure of the ganglions of the sympathetic and those of the cerebro-spinal system is, that the latter appear in general to be less red and vascular, and to contain less of the vesicular or grey neurine; the interlacement of white fibres is more obvious in them, and constitutes the greater portion of each, particularly of the spinal ganglions.

Pl. 138, *fig.* 13, upper part of the great sympathetic nerve: [1], uppermost cervical ganglion; [2,2], branches from it to the accessory nerve; [3,3], junctions with the cervical nerves; [4], branch of the vagus; [5], upper branch of the first cervical ganglion; [6], communicating threads to Jacobson's nerve; [7], threads to the otic ganglion; [8], threads to the oculomotor; [9], threads to the vidian nerve; [10], spheno-palatine ganglion with its branches; [11], pharyngeal and carotid branches of the first cervical ganglion; [12], glosso-pharyngeal nerve; [13], pharyngeal plexus; [17], long or superior cardiac nerve; [18], a cardiac nerve from the vagus; [19], middle cervical ganglion; [20], its upper branches, one of which unites with the first cervical ganglion or with the main trunk, two others with the cervical nerves; [21], middle cardiac nerve; [22], its connecting threads, with the pharyngeal branch of the tenth pair; [23], inferior cervical ganglion; [24], its connexion with the brachial plexus; [25], branches passing into the vertebral canal with the vertebral artery; [26], branches connecting it with the middle cervical ganglion, of which one passes before, the other behind the subclavian artery; [27], lowest cervical ganglion; [28], union of the tenth pair with the cardiac plexus; [29], plexus at the arch of the aorta; [30], plexus between the trachea and the pulmonic artery; [31], tracheal branches penetrating into the lungs; [32,32], pulmonic plexus (from the tenth pair) and the connexion with the cardiac plexus; [33], anterior, [34], posterior cardiac plexus; [35,35], two thoracic ganglions; [36,36], branches to the descending aorta; [37], connexion of a thoracic ganglion with an intercostal nerve; [38], great splanchnic nerve. *Fig.* 14, lower portion of the sympathetic nerve: [1,1,1], three thoracic ganglions, with their roots proceeding from the spinal nerves; [2,2], branches descending to the

aorta; [3,3], cut branches of the tenth pair to the pulmonic plexus; [4], great splanchnic nerve; [5], lesser splanchnic nerve; [6,6], solar or cœliac plexus; [7], semilunar ganglion of the right side; [8], vagus of the right side; [9], do. of the left side, with its numerous branches to the stomach; [10], supra-renal plexus; [11], renal plexus; [12], branches to the intestinal canal; [13], aortic plexus; [14], plexus to the seminal organs; [15,15], two lumbar ganglions, and their connexion with the lumbar nerves and the aortic plexus; [16,16], two sacral ganglions, connected with each other, and with the sacral nerves, so as to form plexuses about the pelvic vessels; [17], sacral plexus of the spinal nerves.

V. ORGANS OF SENSE.

The organs of the senses establish certain relations between man and the external world, by which he obtains all his knowledge of the physical character and of the general and special properties of all surrounding objects. The organs of sense are all symmetrical, and are usually considered as five in number: the nose, or organ of smell; the tongue, or organ of taste; the ear, or organ of hearing; the eye, or organ of sight; together with the integuments, or the organ of touch. Each organ of sense is placed near the surface of the body, is furnished with an appropriate apparatus suited to its particular functions, and is in direct connexion with the nervous centres. The four first mentioned organs are connected with particular parts of the brain, each by its proper nerve. The sense of touch, however, is distributed over the whole surface of the body, and its apparatus being supplied by the posterior or ganglionic roots of the fifth cerebral and all the spinal nerves, is therefore connected with the cerebro-spinal axis generally.

1. Anatomy of the Integuments.

The seat of the sense of touch, by means of which we become cognisant of such peculiarities of matter as temperature, shape, weight, density, &c., resides essentially in the skin proper, although existing to a considerable degree in the mucous membranes. Those which are continuous with the skin share with it in the peculiarities of its anatomy, both consisting of two laminæ, one external or superficial, named cuticle, epidermis, or epithelium, the other deeper, and known as the cutis vera or chorion. Beneath the latter is more or less of areolar or cellular and adipose tissue, which serves to support and conduct the numerous vessels and nerves that supply this highly organized structure.

All parts of the skin, and, indeed, most structures in the body, possess a certain degree of sensibility to temperature and to contact, that is, they possess *touch* generally; but the power of discerning the other qualities of

the body is developed only in certain situations where there is a corresponding refinement and development of sentient papillæ, which are enabled to take cognisance of these qualities with a wonderful degree of nicety and perfection. This power of *tact*, as it has been called, to distinguish it from mere *touch*, resides especially in the integuments of the fingers and toes.

The office of the skin is not fulfilled merely by serving as an investment to the body, and as the seat of touch. It is the seat of an important secretion which serves to purify the blood in a manner somewhat analogous to respiration. This secretion is discharged in the form of a fine vapor termed the "insensible perspiration;" but when the circulation is increased in activity, or when the body is exposed to a high degree of temperature, it is given forth in the form of minute drops, which appear like dewdrops upon the surface, and then becomes the "sensible perspiration" or "sweat." This exhalation carries off from the body a large quantity of water, carbonic acid, saline, and various animal or azotized matters, which are effete or injurious to the system. The importance of a free escape for this cutaneous exhalation is well known. The skin is also the seat of a sebaceous or oily secretion, which preserves it in a soft or pliant state, repels external moisture, and defends it from the drying influence of the air. The skin is also an inhalant and absorbent surface, as shown by its numerous lymphatics arranged in a plexiform manner, and by the fact that immersion in water increases the weight and relieves the thirst. Nutritive substances have even been supplied to the body through the skin, and certain liquids applied to the surface have been subsequently detected in the urine.

To fulfil all these important functions, we find in addition to the three essential elements, namely, the protecting epidermis, the chorion, and the areolar fibrous tissue, that there are superadded numerous glands and follicles, the sources of the perspiration and sebaceous secretion. There is also an extensive and minute capillary net-work of arteries, veins, lymphatics, and nerves. The latter are principally derived from the cerebro-spinal system; and so universally distributed are the vessels and nerves, that the smallest spot on the surface cannot be punctured with the finest instrument without the discharge of blood and the sensation of pain. There are also certain appendages to the skin, as the hair and nails, which will be considered in their proper place.

1. The Cuticle or Epidermis appears to be a thin, semi-transparent, grey lamina, hard, dry, horny, and homogeneous. When minutely examined, however, under water, its deep surface is found to be soft and moist, and numerous fine filaments may be seen to pass between it and the cutis vera. These are probably the elongated and ruptured extremities of the exhalant and sebaceous ducts, together with the sheaths of the fine hairs which invest almost its entire surface. The epidermis is composed of hard, dry laminæ, in each of which may be observed one or two opake spots, the original nuclei and nucleoli of the cells, of a polygonal or irregular form, overlapping each other and adhering to subjacent softer scales. As the scales on the surface become more dry and thin they peel off, and pass away as particles of dust, or bran-like scales, as seen on rubbing the skin

with a coarse towel or hair mitten. The deeper structure of the cuticle consists of softer scales or flattened cells, and the portion in immediate contact with the true skin is in an almost semi-fluid state, containing cells and nuclei. This fluid lymph or blastema contains numerous cell germs or cytoblasts, which gradually enlarge into cells which lie close together, and cover every portion of the papillary surface of the cutis. As soon as the first layer is formed, a second is formed immediately beneath it, separating it from the true skin, and causing its drying and desquamation. The superficial scales adhere by their edges; the middle laminæ of cells by their surfaces; the deep-seated are supported immediately by thin blastema.

Granules of coloring matter are found distributed among the deeper cells and in the connecting lymph, and it is upon the amount and tint of these that the complexion of the skin depends. In the Negro and other dark-colored races, this coloring matter appears as a layer of pigment; it is not, however, a distinct or organized membrane, but merely coloring matter deposited in the interstices of the cells; as the latter approach the surface, any coloring matter they carry along with them is lost as they become dry and hard, partly by evaporation, partly by undergoing some chemical change.

The cuticle being itself insensible and unvascular, forms a most useful investment to the body, defending a highly sensitive surface from pressure and friction, and from the stimulating effects of the atmosphere. It is also invaluable in resisting the evaporation of the fluids of the cutis.

2. Dermis, Chorion, or Cutis Vera. This is composed essentially of areolar tissue condensed into a firm, compact membrane, in which is interwoven more or less of the yellow elastic fibrous tissue, with numerous vessels and nerves. Its inferior surface is loose, open, and cellular, connected and continuous with the areolar tissue of the subjacent parts without any very exact limitation or distinction; the subdermoid cellular tissue contains the cutaneous glands and hair bulbs, and the vascular and nervous ramifications which are to supply the dermis, as also more or less of adipose tissue. This subcutaneous adipose tissue or fat differs in different individuals, according to age, sex, and constitution; it is usually softer and more abundant in the female, and at its maximum in the child.

In the dermis, the upper portion, called the *superficial* or *papillary lamina* (although not a separate layer), presents a condensation of the areolar tissue into a smooth membranous surface which is exquisitely vascular and sensible, and presents beneath the epidermis numerous minute elevated lines called papillæ. This lamina is the seat of a vascular capillary plexus, and in the living body appears uniformly red when the cuticle has been detached. The papillæ are studded over this surface, varying in number and size in different parts of the body; the tactual sensibility of different parts of the body is in proportion to the abundance and size of these papillæ. Thus on the lower surface of the fingers the skin presents numerous curved or arched grooves and ridges; each ridge consists of a row of conical papillæ, and into the intervening grooves the epidermis sinks, and the small exhalant pores open. The exact structure of the papillæ is

difficult to ascertain; each appears to be an eminence or projection of the superficial laminæ of the cutis, with some portion of the fibro-cellular tissue containing blood-vessels, and most probably nerves. The vessels appear as convoluted loops, and constitute the greater portion of the papillæ; nerves also can be traced through the cutis to each papilla. These accordingly may be considered as the true organs of tact.

The excreting apparatus of the skin consists of glands and follicles, some of which supply the perspiration or sweat, others the sebaceous secretion or oily matter.

The sudoriferous or *sweat glands* exist in all parts of the body, imbedded in the dermis or the subdermoid tissue. Each consists of a convoluted tube closed at its inferior extremity, the other end becoming the fine exhalant duct which passes in an oblique or spiral course through the cutis and cuticle, and opens by a minute pore; it is lined by a fine epithelium continuous with the cuticle.

The sebaceous glands, though not so numerous as the last, are very generally diffused through all parts of the skin except the palms of the hands and soles of the feet. They are very distinct in the auditory meatus (*glandes ceruminosæ*), on the inner aspect of the eyelids (*glandes Meibomianæ*), also on the scalp, face, and tip of the nose, around the nipples, and about the anus, scrotum, and corona glandis (*glandes odoriferæ*). They are small, round bodies, imbedded in the dermis; some are simple, soft, convoluted tubes, others are firm and lobulated. In the scalp and other parts where the hairs exist, one or more of them open into the hair follicles. A minute parasitic animal, the Demodex folliculorum, has been found to inhabit these ducts exclusively. The sebaceous secretion serves to keep the surface moist, soft, and pliant, and in particular situations, as in the ear, eyelids, nipples, &c., it answers special purposes; it also co-operates with the sudoriferous glands in separating hydro-carbonous matters from the blood.

The hair and nails are appendages of the skin, but are rather modifications of the cuticle than allied to the true skin.

3. The Nails cover the dorsal surface of the last phalanges of the fingers and toes, and have a tendency to extend around the extremity of each. They are strong, elastic, insensible plates, curved or concave so as to fit closely the cutis; the *root* and *borders* are concealed and fixed in a narrow deep fold in the cutis, termed the *nail follicle;* the exposed portion or *body* is convex and ends in the *free margin.* The surface of the cutis to which the body of the nail adheres is called the *matrix*, and is so vascular that the red color is seen through the nail; at the root and a short distance beyond it, it is less vascular and more dense, and causes the semi-lunar white spot at the base of the nail, called the *lunula.* The absence of this lunula is said to characterize the colored races, as distinguished from the white. In the follicle, at the root and borders, are a number of papillæ which form the nail by secreting the blastema in which are formed cell germs; these become flattened and compressed, dry, and harden into nail. As the nail elongates, it thickens by additions to its concave surface from the matrix, and increases in breadth by secretion along its borders. The cuticle is

continuous with the nail a little beyond its root and lateral borders, and is also continued from the back of the pulpy end of the finger to its concave surface near the end or free edge; as the nail is thus continuous with the cuticle, so is the matrix with the adjoining cutis. The nails not only protect the sensitive ends of the fingers, but aid them as instruments of prehension, as well as in various manual operations; they also afford a firm point of support behind the tactile papillæ, which is of essential service in the exercise of touch.

4. The Hairs. These cutaneous appendages, like the epidermis and nails, are insensible and non-vascular; they exist in all parts of the body except the palms of the hand and soles of the feet, varying very much in strength, form, color, and extent, in different situations. On the greater portion of the body, they are short, soft, and downy; on the head, in the eyelids, axilla, and on the pubic region, they are much longer and stronger; the extent, however, of their development varies with the age, sex, and temperament of the individual. The loose or projecting portion of a hair is called the *shaft*; the *root* is fixed in a follicle composed of an involution of the cuticle and of the superficial lamina of the cutis; this follicle is depressed through the cutis, enlarges into a pyramidal or bulbous form, and is imbedded in the areolar or adipose tissue, from which it receives its vessels, and in which it is so firmly implanted as not to be disturbed by pulling out the hair. The whole follicle is lined by the involuted skin, and at the bottom the cutis presents a highly vascular papilla or pulp, which secretes the matter of the hair. Thus the vessels of the pulp give out the lymph containing cell germs; these become cells with nuclei, and are gradually condensed and elongated into a scaly fibrous substance which is continually pushed forwards by additions from beneath, and escapes through the opening in the epidermis, generally in a slanting manner. The cells forming this outer surface or *cortex* of the hair are flat and hard, and inclose a more loose fibrous texture named the *medulla* or pith; these external scales are successively produced, the last formed overlapping the preceding. Owing to the less density of the internal cells, the hair when magnified has a cellulo-tubular appearance. Thus the hair is nothing but cuticle specially modified by the papilla on the cutis vera at the bottom of the follicle. Pigment granules are also intermingled with and adherent to the cells at the root of each hair; on these the color of the hair depends. Into the hair follicle one or more sebaceous ducts open, the secretion of which lubricates the hair and imparts to it its oily character.

5. The Subcutaneous Cellular Tissue is a soft, extensile substratum of the skin, composed of contractile fibres and plates of cellular membrane. It serves to connect the skin with the subjacent fascia, and to conduct vessels and nerves to the true skin; it incloses angular cavities or spaces intercommunicating freely, and filled during life with a watery exhalation.

6. The Adipose Tissue at one time was supposed to be identical with cellular. It is, however, characterized by consisting of numerous short sacs having no opening or communication, each sac being a delicate simple membrane, supplied with blood-vessels and secreting from its cavity the

substance called fat. In the cellular or areolar tissue, on the other hand, we have numerous bands or threads of white fibrous tissue crossing each other, and leaving interstices which communicate freely. The two tissues are usually associated together, the adipose being inclosed in the meshes of the areolar, but in some situations, as in the medullary canal of the long bones (where it is known as the marrow), in the omenta, along the mesenteric vessels, and upon the heart, the adipose tissue may be abundant, with little or no cellular.

Adipose tissue consists of two distinct elements, the secreting membrane and the secreted product. The former consists of fine transparent membranous cells surrounded by capillaries; each sac is somewhat round, but by aggregation and consequent compression is made to assume various figures. The vessels pass in the interstices between the cells, and surround each by a delicate inosculation. The adeps or fat, which occupies each cell, is a soft, yellowish, oily substance, presenting a great variety with the individual. In youth it is most abundant towards the exterior, the reverse existing in old age. The fat contributes to the covering of the body, and being a bad conductor of heat, assists in retaining its temperature; by filling up numerous interstices, it adds to the compactness and symmetry of the system; it may also serve as a reservoir of nutritive materials from which the system may derive an occasional supply.

Pl. 129, *fig.* 24, vertical section of the skin showing its microscopical structure: [1], epidermis with its undulating lines; [2], sudoriferous gland and canal; [3], cutis vera; [4], apparatus for secreting pigment substance; [5], sebaceous gland with its duct; [6, 6], papillæ; [7], blood-vessels of the skin. *Fig.* 25, vertical section of the thumb to exhibit the insertion of the nail: [1], nail; [2, 2], continuation of the cuticle; [3], cutis vera; [3] (left hand side), adipose tissue; [4], fold of skin containing the root of the nail; [6], section of the terminal bone of the thumb. *Fig.* 26, body of the thumb nail: [1], lateral fold; [2], ridges caused by the linear rows of papillæ on the subjacent cutis vera; [3], lunula or spot at the base of the nail.

2. Anatomy of the Nose, or Organ of Smell.

The nose is situated between the orbits, above the mouth and glottis, and in front of the pharynx and of each tympanum, communicating with all these regions. Though median in position it is really a double organ, being completely divided by a partition or septum into two symmetrical portions, called the nares or nasal fossæ. The nasal passages have a twofold use: they constitute the organ of smell, the olfactory nerve being distributed to the vascular membrane covering their irregular and convoluted aspect; and secondly, they serve as avenues to the respiratory organs. We may conveniently examine the nose as composed of two portions: the one, anterior or external (the nose proper), consisting of cartilages and soft parts; the other, posterior or internal, the nares or nasal fossæ, composed of bones covered by highly vascular mucous membrane.

The Nose is essentially formed of cartilages; one occupies the median line or septum, the others are placed on each side and form the alæ. They are continuous laterally with the superior maxillary, and superiorly with the margin of the nasal bones; inferiorly they bound two oval openings, *the nostrils*. Each nostril has its long axis, antero-posterior, and is partly surrounded by stiff hairs (*vibrillæ*), which bend across it and instantaneously give notice of the entrance of foreign particles. The skin covering the tip of the nose is thickened, and furnished with numerous sebaceous follicles, the mouths of which frequently appear like black dots, owing to the adhesion of extraneous particles. The secretion of these follicles may often be forced out in fine long threads like small worms.

The cartilages of the nose or fibro-cartilages are five in number, one in the centre, one at each side, and one inferiorly in each ala. The *septal* or *median cartilage* is a true cartilage of considerable strength; it not only separates the nostrils, but also the anterior portions of the nasal fossæ. It is inclosed in thick mucous membrane, and is not always vertical, but may project to one side.

The *lateral nasal cartilages* are two on each side, superior and inferior. The *superior lateral* is attached externally and posteriorly to the nasal process of the superior maxillary bone and to the inferior margin of the nasal; anteriorly and internally to the opposite one and to the septal cartilage, and inferiorly by fibrous tissue to the inferior cartilages. The *inferior lateral* or alar cartilages form the upper part of each ala, the tip or lobe and the boundary of the nasal openings. All the lateral cartilages are readily acted on by the superimposed muscles, which can move the whole organ, or alter the shape of the openings, but cannot perfectly close them.

Pl. 132, *fig.* 29, left side of the nose of an adult, the cuticle supposed to be removed for the purpose of more clearly exhibiting the openings of the sebaceous follicles. *Fig.* 30, lateral view of the bones and cartilages of the nose: *a*, *a*, skin of the nose; *b*, left nasal bone; *c*, left superior lateral cartilage; *d*, left alar cartilage with its three appendages, *e*, *f*, *g*, which are attached to each other by the ligaments *h*, *i*, *k*. *Fig.* 31, anterior view of the nasal cartilages: *a*, *b*, nasal bones; *c*, *d*, superior lateral cartilages; *e*, septum; *f*, *f*, small cartilages proceeding from it; *g–o*, alar cartilages with their three appendages. *Fig.* 32, outline view of the preceding figure. *Fig.* 33, inferior view of the nasal cartilages: *a*, *b*, *c*, *d*, outline of the nose; *e*, septal or median cartilage; *f*, extremity of the upper jaw to which it is attached; *g–k*, alar cartilage of the left side with its three appendages; *l–o*, do. of the right side. *Fig.* 34, superior lateral cartilage of the nose. *Fig.* 35, septal cartilage of the nose. *Fig.* 36, left alar cartilage. *Fig.* 37, do. with its three appendages (from without). *Fig.* 38, do. from within. *Figs.* 39 and 40, the three small cartilaginous appendages, without and within.

The Nasal Fossæ are bounded by several bones which are covered by a very delicate periosteum; to the anterior part of the bones of the nose are attached the cartilages already described. These several bones are the nasal, frontal, ethmoid, sphenoid, superior maxillary, palatine, unguis, spongy, pterygoid, and vomerine bones. The external wall of each naris is

deeply grooved by three fossæ, the superior, middle, and inferior meatus; these are situated between the spongy bones, the middle being the widest. The nasal or lachrymal duct opens into the anterior third of the *inferior meatus*, the Eustachian tube behind. Into the *middle meatus* the antrum maxillare opens by a small oblique slit, in front of which is a groove named the infundibulum, leading from the frontal sinus; into this groove the anterior ethmoidal cells open. The posterior ethmoidal cells and the sphenoid sinuses open into the *upper meatus*. Each naris opens posteriorly into the pharynx above the velum, by an oblong oval opening, separated from each other by the vomer.

All the internal surface of the nose and of the communicating sinuses is lined by a soft, vascular, and highly sensitive mucous membrane; this is the *pituitary* or *Schneiderian membrane*. The olfactory nerves are distributed to it on the septum and ethmoidal region in the form of numerous plexuses; it is also supplied on each side and on the septum with branches from the ophthalmic and superior maxillary divisions of the fifth pair. The olfactory or first pair of nerves endow the superior portion of this membrane with its peculiar sense or power of smelling; while its general acute sensibility depends on the fifth pair, the general nerve of feeling of the head.

Such bodies can alone be considered as capable of imparting the sensation of smell as are capable of being vaporized or dissolved in the atmosphere. The essential conditions of smell, however, are not yet satisfactorily ascertained; so much is certain, that the odorous particles must come in contact with the nerves, and especially by being inhaled in ordinary nasal respiration. If the breath be held, no perception of odor takes place, and if a piece of camphor be held in the closed mouth during nasal exhalation, comparatively little odor will be perceived. The particles of matter, nevertheless, do not come into immediate contact with the nerves, since the mucus of the nose is interposed, together with the basement membrane of the Schneiderian. It may be that solution in the mucus is necessary to this sense, as when the nasal passages are dry it is much enfeebled.

Pl. 132, *fig.* 27 *a*, a portion of the Schneiderian membrane with its nerves of natural size; *fig.* 27, *b*, the same magnified three diameters: *a*, *b*, dura mater; *c*—*f*, section of the Schneiderian membrane; *g*, *g*, section of the cribriform plate of the ethmoid bone; *h*, *h*, foramina in it for the transmission of nervous filaments; *i*, branch of the olfactory nerve, cut off to show the following branch *k* with the manner of its escape from the dura mater *l*, and the passage of the nerve through the bone *m*; *n*, *o*, *p*, arteries of the Schneiderian membrane. *Fig.* 26, distribution of the olfactory nerve on the septum of the nose: *a*, *b*, *c*, *d*, nerves of the olfactory; *e*, nervous branch from the fifth pair; *f*, *g*, superior posterior nasal nerves from the second branch of the fifth pair; *h*, superior cutaneous nasal nerve, from the infraorbital nerve; *i*, *k*, apparent boundary of the branches of the olfactory nerve. *Fig.* 28, nervous plexus of the lining membrane of the nose: $^{1-8}$, basal extremities of the first eight cerebral nerves; *a*—*d*, olfactory bulbs with their threads, $^{12, 13}$, passing through the cribriform plate; $^{9 \text{ to } 12}$, larger portion of the fifth pair of nerves; *e*, *f*, *g*, first branch of the fifth pair.

h—k, second branch. *Figs.* 41 and 42, two sections of the nasal cavities: *fig.* 41, the lower, *fig.* 42, the upper: *a*, outline of the nose; *b*, *c*, nasal bones; *d*, *e*, frontal bone; *f*, *g*, *h*, *i*, ethmoid bones; *g*, *i*, *k*, *l*, alar process and sphenoid bone (cut edge); *r*, *r*, middle lamina of the ethmoid bone (cut edge); *s*, *s*, and *t*, *t*, thickness of the mucous membrane of the nose; *u*, *u*, length and breadth of the left, *v*, *v*, of the right nasal cavity; *w*, *w*, *x*, *x*, cells of the ethmoid bone; *y*, *z*, membrane reflexed. *Fig.* 43, posterior surface of a vertical section of the nose; *a*, *b*, nasal cartilages; *c*, *c*, septal cartilage; *d*, *d*, Schneiderian membrane; *e*, *e*, hairs and mucous glands; *f*, *g*, nostrils. *Fig.* 44, posterior sectional surface of the nasal cavities: *a—f*, cut edge of various bones; *g*, *h*, lachrymal sac and lachrymal duct opening into the inferior meatus; *i*, *k*, *l*, *m*, section of the Schneiderian membrane; *n*, *n*, the surface of the membrane turned towards the nasal cavity; *p*, *q*, lachrymal sac and lachrymal duct of the left side; *r*, *r*, inner bony wall of the maxillary sinus. *Fig.* 45, posterior sectional surface of the nasal cavities and the communicating sinuses: *a*, *b*, frontal bone; *c—l*, ethmoidal; *m*, *n*, left and right superior turbinated bones; *p*, *p*, vomer; *q—y*, upper jaw; **a**, **f**, Schneiderian membrane; **g**, **g**, opening of the left lachrymal canal; **h**, opening of the right; **k**, **l**, **m**, opening of the maxillary sinus on the right side, **m** is a probe introduced; **n**, **o**, **p**, section of the periosteum of the orbit; **s**, section of the soft palate; $^{1-6}$, teeth.

3. Anatomy of the Ear, or Organ of Hearing

By means of the sense of hearing an animal is enabled to take cognisance of sounds and of all their variations. Sound is the result of any impulse conveyed to the organs of hearing, by undulations of air, these organs being so constructed as to receive these undulations, and so organized as to become sensible to them and to convey the impressions to the sensorium. This sense, next to vision, is most valuable to man, as forming the bond of social union and the great inlet for all knowledge conveyed by voice and language. Each organ consists of a special nerve expanded on membranes, and endowed with the properties of sensibility to the varying impressions of sound and of conveying these impressions to the sensorium; and secondly, of a physical apparatus fitted for receiving, conducting, and in some measure regulating these impulses in their course to the sentient nerve.

We may divide the ear into an external, middle, and internal portion. The external comprises the auricle, commonly called ear, and the external meatus or tube; the middle consists of the tympanum or drum with its chain of small bones; and the internal or true ear is called the labyrinth, and comprises the vestibule, cochlea, semicircular canals, meatus auditorius internus, and auditory nerve. This portion is lodged in the petrous division of the temporal bone, and is thereby protected from external pressure or injury.

A. External Ear.

The external ear, or auricle, is situated at the side of the head: it consists of the auricle or pinna and the external meatus, which terminates at and is closed by the tympaum.

THE PINNA, or AURICLE, commonly termed the ear, is the external portion, composed of cartilage, ligament, and a few muscular fibres, the whole inclosed in a duplicature of the skin. It is convex towards the head, and concave externally, in which aspect it presents varions irregularities, all tending towards the meatus. The convex border which forms the outline of the ear is called the helix; superiorly this edge is thin, and curled outwards so as to bound a depression named the *fossa innominata;* anteriorly it bends downwards and backwards into the concha and above the meatus. Anterior and inferior to the helix is the semicircular prominence called the *antihelix.* This is narrow and prominent behind; as it ascends it becomes broader, retires from the surface, and divides into two crura, which run in beneath the edge of the helix; this depression between its crura is named the *scaphoid* or *navicular fossa.* Anterior to and overhanging the meatus auditorius, somewhat like a valve, is the eminence called *tragus*, of a triangular form. The free apex of this is directed towards the concha, and the inner surface is beset with strong coarse hairs or vibrillæ, which extend across the orifice of the meatus. When pressed backwards or inwards, the tragus can cover the meatus. Opposite to the tragus and separated from it by a deep round notch is the *antitragus*, a small tubercle connected with the lower extremity of the antihelix. Within the antihelix, tragus, and antitragus, and traversed above by the helix, is the large and deep depression called the *concha*, into which all the other grooves converge; it leads directly downwards into the meatus. The lower pendulous part of the auricle is called the *lobe*, and contains none of the cartilage which constitutes the skeleton of the rest of the ear.

The *ligaments* of the auricle are the *anterior*, from the root of the zygoma to the anterior part of the helix, and to the tragus; and the *posterior*, from the mastoid process of the concha.

Of the *muscles of the external ear* we have already considered those which move it on the head (anterior or attrahens, superior or attollens, and the posterior or retrahens). The intrinsic muscles, or those which only pass from one part of the cartilage to the other, are named from the eminences to which they are attached. They are the major and minor helices, the tragicus, anti-tragicus, and transversus auricularis. These muscles, though only rudimentary in man, are highly developed in some of the inferior animals.

Meatus auditorius externus is a tube leading from the concha to the membrana tympani; it is about an inch and a quarter long, with the external half of cartilage, the remainder of bone. By drawing the auricle upwards and backwards we can partly straighten the canal, and, with a strong light directed in it, we can see down to the membrana tympani. The bony portion of the meatus is wanting in the child, its place being

supplied by a mere ring. The auditory canal is lined by the integument, continued from the auricle; the cutis ceases at the margin of the lower extremity, but the cuticle is continued over the membrana tympani. The skin, from a little distance within the external orifice to within a quarter of an inch of the tympanum, is perforated by numerous small openings, the openings of the sebaceous follicles and of the ceruminous glands. These glands secrete the cerumen, or ear wax.

B. Middle Ear.

The middle ear or tympanum is the space within the membrana tympani, external to the osseous walls of the vestibule and labyrinth, in front of the mastoid cells, and communicates anteriorly with the Eustachian tube. It contains air and a little fluid, and is traversed by the chain of small bones, and by fine nerves and vessels. Its walls are lined by a fine mucous membrane, continuous through the Eustachian tube with that of the nose.

1. Membrana Tympani. This is situated at the inner and lower extremity of the meatus, separating it from the cavity of the tympanum or drum, the outer wall of which it forms. It is a thin, dry, semi-transparent membrane, nearly circular, with the vertical diameter a little longer than the transverse or antero-posterior. The inner surface of the membrana is directed upwards and inwards, and adheres intimately to the handle of the malleus bone. Although thin and semi-transparent, the membrana tympani consists of three distinct layers, an external or epidermis, an internal or mucous, and a middle or fibrous. We have already referred to the two former; the latter presents the appearance of fibres radiating from the exterior to the malleus, into which they are inserted.

The internal or vestibular side of the tympanum presents several points of observation. At its upper part is situated the kidney-shaped foramen, *fenestra ovalis* or *vestibuli.* This is directly opposite the membrana tympani, and in the dry bone leads to the vestibule; in the recent state it is closed by a membrane. The base of the stapes also closes this opening. Below the foramen ovale is the bony projection of the *promontory*, which corresponds to the first turn of the cochlea, and on the surface of which there are delicate grooves converging below to a common canal, which transmits the nerve of Jacobson from the glosso-pharyngeal nerve. Behind the fenestra ovalis is the bony *pyramid*, the apex of which is perforated by a small canal. Below and behind the promontory is the *foramen rotundum* or *fenestra cochleæ*, which in the recent state is closed by membrane.

The posterior wall of the tympanum presents a large irregular opening at its upper part, leading into the mastoid cells. The anterior wall tapers off into the Eustachian tube, above which are the cochleariform osseous plate and the canal for the tensor tympani muscle.

2. The Eustachian Tube is a narrow canal, about an inch and a half long, leading from the tympanum obliquely towards the back of the nose, where it opens on the side of the pharynx and on a level with the inferior spongy bone. The tympanic portion is chiefly osseous; the remainder is composed of cartilaginous, fibrous, and mucous tissues. The use of this tube

is to admit external air into the tympanum, by means of which the membrane is enabled to resist the pressure of the atmosphere; it also serves to conduct the secretions of the tympanic cavities into the fauces.

The tympanum also presents another small opening or canal, anteriorly and inferiorly, which leads to the inner side of the fissure of Glasser, and transmits the chorda tympani nerve. The cavity of the tympanum is traversed by a chain of small bones, one attached externally to the membrana tympani, and another to the membrane in the fenestra ovalis.

3. Ossiculi of the Ear. The small bones of the ear are three, or according to some, four in number, and are named from a fancied resemblance, *malleus* or hammer, *incus* or anvil, and *stapes* or stirrup. The fourth, or *orbicular*, is by many considered a mere epiphysis to the long leg of the incus.

Malleus is immediately within the membrana tympani, and connected to, it; it presents a head, neck, manubrium or handle, and long and short processes. The head presents an articulation for the incus.

Incus is placed internal and posterior to the malleus, and bears some resemblance to a bicuspid tooth; it presents a body or head, and a short and long crus. The body is lodged in the recess of the tympanum, and receives the head of the malleus in its deep concave surface. The short crus occupies the opening into the mastoid cells. The long crus descends vertically in the tympanum, parallel to the handle of the malleus. At its extremity is the round tubercle, which is sometimes united to it like an epiphysis, and at others separable from it, when it is called *os orbiculare* or *lenticulare.*

The *stapes*, or stirrup, is placed horizontally between the crus of the incus or orbicular bone, and the fenestra ovalis, to the membrane of which its base is attached. Its head presents a small cavity for articulation with the orbicular bone, or with the crus of the incus; its base is a thin plate, closing the fenestra ovalis.

The articulations between these three bones are furnished with synovial membranes and capsular ligaments, and are further secured in their places by three ligaments. One extends from the head of the malleus to the upper wall of the tympanum; another connects the short process of the incus with the opening of the mastoid cells; and a third extends from the margin of the fenestra ovalis to the margin of the base of the stapes.

4. Muscles of the Tympanum are only two in number, the stapedius and the tensor tympani. The *stapedius* arises within the pyramid, and is inserted into the back part of the neck of the stapes. The *tensor tympani* is a very distinct and long fibro-muscular cord, chiefly lodged in the bony canal above the cochleariform process and Eustachian tube. It arises from the cartilage of that tube, and from the adjacent portion of the sphenoid bone. It is inserted into the inner, anterior, and superior portion of the handle of the malleus. The use of the stapedius muscle is not well ascertained; that of the tensor tympani is to draw the handle of the malleus inwards and forwards, by which the membrane is rendered more tense. Two other muscles, *laxator major* and *minor* as described by some authors, appear to be only ligamentous fibres.

Pl. 132, *fig.* 1, left ear: *a–e*, helix; *f–k*, antihelix; *l*, tragus; *m*, antitragus; *n*, lobe of the ear; *o*, *p*, depressions between these elevations; *q*, concha. *Fig.* 2, muscles of the ear: *a–e*, cartilages of the ear; *f–p*, elevator or attollens; *q–t*, attrahens; *u–z*, two retrahens. *Fig.* 3, small muscles on the outside of the ear: *a b c*, greater; *d e f*, smaller muscles of the helix; *g*, *h*, muscle of the tragus; *i*, *k*, muscle of the anti-tragus. *Fig.* 4, muscle of the inside of the external ear: *a–f*, transverse muscles of the ear. *Fig.* 5, section of the tympanic cavity: *a*, meatus opened; *b*, fossa on the inferior wall of the meatus; *c*, fold for the membrana tympani; *d*, *d*, tympanic cavity proper; *e*, entrance into the mastoid process; *f*, cells of do.; *g*, promontory; *h*, fenestra ovalis; *i*, Fallopian canal; *k*, superior semicircular canal; *l*, mastoid process. *Fig.* 7, membrana tympani from the inside: *a*, annular fold into which it is fastened; *b*, malleus; *c*, elevation; *d*, *d*, fibres of which it consists. *Fig.* 8, ossicles of the ear in their proper positions: *a–d*, temporal bone; *e*, tympanic ring; *f*, malleus; *g*, incus; *h*, stapes. *Figs.* 9 and 10, malleus from two directions magnified: *a*, long process or gracilis: *b*, short process; *c*, manubrium; *d*, neck; *e*, head; *g*, articulating face for the incus. *Figs.* 11 and 12, incus: *f*, body; *g*, short process or crus; *h*, long or inferior crus; *i*, os lenticulare; *k*, articulating face for the malleus. *Figs.* 13 and 14, stapes: *a*, *b*, head; *c*, neck; *d e g*, crura; *f*, base. *Fig.* 15, temporal bone: *a*, *b*, Eustachian tube; *e*, *f*, tensor tympani; *g*, *h*, *i*, stapedius muscle.

C. Internal Ear.

This is the essential part of the organ of hearing. It lies deeply buried in the petrous bone, and consists of a number of curiously formed channels and spaces wrought out of the osseous structure, and containing delicate membranous tubes filled with fluid. On these the terminal branches of the sentient nerve are expanded. The internal ear or labyrinth consists of two portions, an osseous and a membranous. The *osseous* labyrinth consists of three distinct compartments: one in the centre, termed the vestibule; one behind this, composed of three semicircular canals; and one in front of it, the cochlea. Both the anterior and posterior compartments communicate with the vestibule; and the meatus auditorius internus communicates with each of these by minute foramina for the transmission of the auditory nerve.

1. Meatus Auditorius Internus is shorter and smaller than the external. It is scarcely a quarter of an inch in length, and, lined by the dura mater, it leads from the cranium directly outwards, ending in a cul de sac, subdivided into two by a horizontal bony crest. In this depression are seen various minute foramina for the transmission of the nerves.

2. The Vestibule, or central cavity of the labyrinth, is a very small space placed between the fenestra ovalis and the meatus auditorius internus. Its form is very irregular, owing to dilatations in three directions, these bearing the names respectively of superior ventricle or cornu, inferior and posterior, and inferior and interior. In each cornu there are certain openings. On the tympanic side of the vestibule is seen the fenestra ovalis, closed by

membrane and the base of the stapes. The inner or cerebral wall of the vestibule corresponds with the base of the meatus internus. It is cribriform, and transmits some fibrillæ of the auditory nerve, and some fine capillary vessels. In the *posterior* and *lower horn* are seen three distinct foramina, the orifices of the semicircular canals. In the *superior cornu* are the two other openings of these tubes. In the *inferior* and *anterior cornu* is a distinct oval opening, which leads downwards and forwards into the vestibular scala of the cochlea. Thus there are seven large foramina in the vestibule. The smaller foramina are: 1, those in the cribriform lamina for the auditory nerves; 2, the *aqueductus vestibuli*, which opens in a suture on the posterior wall internal to the common opening of the semicircular canal, and transmits a small vein. In the anterior horn there is a depression (*fossa hemisphærica*), cribriform, for the passage of nerves. It is separated from another cribriform depression (*fossa elliptica*) by a prominent bony ridge (*eminentia pyramidalis*).

3. Semicircular Canals are three long tubes imbedded in the petrous bone, behind the vestibule, and communicating with it. They are curved so as to form nearly three fourths of a circle. They open by each extremity into the vestibule; two, however, unite by their adjoining extremities, so that but five openings are presented. Two of these canals have a perpendicular, and one a horizontal direction.

4. The Cochlea is the most anterior part of the labyrinth, and is a very complicated apparatus. It derives its name from a strong resemblance to the shell of a snail. It may be considered as a tapering tube, closed at its smaller extremity, coiled round a central pillar, the tube itself being subdivided by a partition into two semi-cylindrical tubes. It presents for notice, the tube, the lamina spiralis, the axis or modiolus, and the scalæ.

The tube is about an inch and a half long, and descends two turns and a half. The second turn lies, at its beginning, within the first, but near its end rises above it. The *axis* or *modiolus* is a conical tube, whose summit is expanded like a funnel. It arises from the base of the cochlea, and is directed almost horizontally outwards: the coils of the cochlea and of the lamina spinalis twine round it. The whole of this axis is concealed by the tube of the cochlea; its base or origin is pierced with foramina for the auditory nerves. The apex is expanded into the *infundibulum.* The centre of the modiolus is traversed by canals for branches of the auditory nerves and blood-vessels.

The *lamina spiralis* is a very thin plate of bone wound spirally, like the turns of a screw, round the modiolus, into which its inner margin is inserted. In the dry bone, the outer margin is free, but in the recent state it is continued by membrane to the opposite and outer walls of the tube. If unwound and separated from the modiolus, it would present the appearance of an elongated isosceles triangle. The apex of this stands out from the modiolus in the form of a hook (*the hamulus of the lamina spiralis*). The lamina is composed of two thin plates, between which the cochlear vessels and nerves are distributed.

The two secondary cavities into which the cochlear tube is divided by

the lamina spiralis are called *scalæ*. The superior is called *vestibular scala*, from communicating directly with the vestibule; the other is the *scala tympani*, and communicates with the tympanum through the fenestra rotunda. Although elsewhere separated, the two scalæ communicate near the summit of the cochlea by a common opening called *helicotrema*. Near the termination of the scala tympani at the fenestra, is the opening of the *aqueduct* of the *cochlea*, a canal for a small vein.

Membrane lining the labyrinthic cavity. This is an extremely delicate membrane, of a fibro-serous character. One surface is closely adherent to the bone, like a periosteum; the other is smooth, and secretes the *perilymph* or *aqua Cotunnii*, a semi-fluid substance.

5. The Membranous Labyrinth. This is not so extensive as the osseous labyrinth, as it does not enter the cochlea. It is separated from the walls of the osseous portion in which it occurs by the perilymph. The membranous labyrinth is itself filled by a liquid called *endolymph* or *liquor of Scarpa*. The labyrinth consists of the common sinus, the sacculus, and the membranous semicircular canals.

The *common sinus* or *vestibular ventricle* is an elongated, laterally compressed pouch, which occupies the posterior part of the vestibule; the semicircular canals are continuous with it, and open into it by fine orifices; it floats in the perilymph, and is distended by the endolymph.

The *sacculus vestibuli* is much smaller than the sinus; it is round and situated inferior and anterior to the sinus, to which it adheres; anatomists are not agreed as to whether the two communicate or not.

The *membranous semicircular canals* have precisely the same form as the osseous canals, presenting the same number of ampullæ or ovoid vesicles. They are surrounded by perilymph and distended by endolymph. The otolithes of certain fishes are represented in man by a powder composed of carbonate and phosphate of lime, and known as *otoconia*. The grains composing this powder are supposed to play an important part in the physiology of hearing, by communicating to the nervous expansion a more vivid and energetic impression than a single liquid could effect.

6. Nerves of the Ear. The essential nerve of sense is the portio mollis of the seventh pair, or the *auditory nerve* proper. This enters the meatus internus, and at the bony crest at the bottom of this canal divides into two branches, an anterior, larger, for the cochlea, and a posterior for the vestibule and semicircular canal. The *vestibular nerve* immediately separates into three sets of fasciculi, superior, middle, and inferior. The superior pass into the superior ventricle of the vestibule, and are expanded on the sacculus communis and on the ampullæ of the semicircular canals. The middle set pass through the macula cribrosa into the anterior ventricle, and expand on the sacculus proprius; while the posterior set pass through the posterior wall of the vestibule, and are lost on the ampullary dilatation of the oblique semicircular membranous canal.

The *cochlear nerve* resembles a flat tape rolled on itself lengthwise. It passes downwards to the depression at the bottom of the internal meatus, where it divides into a number of fine filaments, which enter the small

bony canals leading into the substance of the axis, and pass out between the osseous plates forming the lamina spiralis. The nerve divides into numerous branches which anastomose with each other, and spread out into a delicate nervous membrane, or according to some, terminate in the form of papillæ.

The *facial* or *portio-dura nerve* enters the meatus along with the auditory, and entering the aqueduct of Fallopius passes to the hiatus Fallopii, where it is joined by the superior petrosal branch of the vidian and presents a ganglion enlargement. The *chorda tympani* may be regarded either as the continued petrosal branch of the vidian, or as proceeding from the last-mentioned ganglion. It passes into the ear, winds among the tympanic bones, and escapes by a bony canal in the glenoid fossa. The *tympanic plexus* is a delicate network, chiefly formed by the tympanic branch of the glosso-pharyngeal nerve, or the nerve of Jacobson.

Having thus considered the general features of the ear, we may proceed to a brief reference to the probable functions of its different parts. The auricle or external ear collects and concentrates the sounds which fall upon it; and by the motion of the head and spine it can be turned in every direction to receive them. The meatus auditorius conducts and reflects from its sides the sonorous undulations to the membrana tympani, which is thereby thrown into vibrations, and these are transmitted by the chain of bones to the membrana vestibuli, and partly to that of the foramen rotundum, through the air and fluid which the tympanum contains. The Eustachian tube, by admitting air into this chamber, favors these vibrations as well as the motions of the ossicula; it may also allow the escape of such sonorous impulses as strike on the walls of the labyrinth, and which might produce an echo or confusion of sound. The mastoid cells may also contribute to this effect as well as lighten the bone. Finally, the impressions impinge on the membranous labyrinth on which the sentient nerves are expanded, and then convey the impressions to the sensorium. Sonorous undulations, which strike the bones of the head and face, and the teeth, are transmitted through these solid structures to the temporal bone, and especially to the cochlea, on which numerous auditory nerves are expanded.

Pl. 132, *fig.* 16, relation of the ossicles of the ear to the nerves which lie between them: [4], membrana tympani; [6], handle of the malleus; [11], process of the incus; [14], tensor tympani; [5], chorda tympani. *Fig.* 17, Jacobson's plexus; *a*, promontory; *b*, portion of the mastoid process; *c*, malleus; *d*, incus; *e*, stapes; *f*, fenestra cochleæ; *g*, internal carotid artery; *h*, Eustachian tube; *i*, tensor tympani; *k*, laxator tympani; *l*, Jacobson's nerve; *m*, a recurrent branch of do.; *n*, branch to the fenestra cochleæ; *o*, continuation of the main trunk; *p*, inferior branch for the carotid artery; *q*, superior branch of Jacobson's nerve from which passes a thread, *r*, to unite with the branch, *s*, to supply the Eustachian tube at *t*; *u*, first thread to the fenestra vestibuli; *v*, second thread; *w*, branch to the promontory and the Eustachian tube; *x*, end of Jacobson's nerve, as the superficial petrosal which finally joins the otic ganglion. *Fig.* 18, bony labyrinth from above,

magnified four diameters: *a*, *b*, *c*, *d*, cochlea; *e–g*, vestibule; *h*, *i*, *k*, posterior semicircular canal; *l*, *m*, *k*, superior do.; *n*, *o*, *p*, horizontal do. *Fig.* 19, bony labyrinth from below, or from the side of the meatus auditorius internus: *a–c*, base of the cochlea with the small foramina for the passage of vessels and nerves; *d*, foramina for the nerves of the membranous labyrinth; *e*, cribriform lamina for the ampullæ; *f*, foramen for the aqueduct of the vestibule; *g*, *h*, *i*, posterior semicircular canal; *i*, *k*, *l*, superior do.; *m*, *n*, *o*, horizontal do.; *p*, opening for the nerve of the posterior semicircular canal; *q*, aqueduct of the cochlea. *Fig.* 20, labyrinth magnified four diameters to show the distribution of arteries in its interior: *a*, first coil of the cochlea broken open; *b*, inner surface covered by the periosteum; *c*, bony portion of the lamina spiralis in the first coil; *d*, vestibule; *e*, canal for the malleus muscle; *f*, *g*, *h*, artery for the labyrinth; *k*, posterior semicircular canal with its arteries; *l*, superior do.; *m*, horizontal do.; *n*, common opening of the superior and posterior semicircular canal. *Fig.* 21, general relations of the membranous labyrinth: *a*, cochlea; *b*, vestibule; *c–f*, semicircular canals; *g*, lamina spiralis; *h*, edge of the lamina; *i*, sinus and sacculus of the vestibule; *k*, *l*, *l**, ampullæ of the three semicircular canals; *m*, horizontal canal; *n*, auditory nerve; *o*, cochlear nerve; *p*, *q*, branches to the ampullæ; *r*, middle branch to the sinus of the vestibule. *Fig.* 22, labyrinth opened: *a–e*, lamina spiralis; *f*, bony, *g*, cartilaginous portion; *h*, *i*, membranous portion; *l*, space between the sinus and sacculus; *m*, sinus with which the fine openings of the semicircular canals communicate; *n*, posterior semicircular canal; *o*, superior do.; *p*, horizontal do., all with their ampullæ. *Fig.* 23, labyrinth from beneath to show the common opening of the superior and inferior semicircular canals, and the course of the auditory nerve: *a*, cochlea; *b*, vestibule; *c*, *d*, *e*, posterior semicircular canal; *f*, common opening; *g*, horizontal canal; *e*, *h*, superior canal; *i*, facial nerve; *k*, auditory nerve; *l*, cochlear nerve; *m*, nerve for the superior and horizontal semicircular canal; *n*, nerve to the sinus; *o*, small nerve for the ampullæ of the posterior canal. *Fig.* 24, magnified representation of the nerves of the labyrinth in the vestibule and on the ampullæ. *Fig.* 25, distribution of the cochlear nerve on the lamina spiralis of the cochlea. *Fig.* 6, connected view of the different portions of the ear: *a*, external ear; *b*, *c*, meatus auditorius; *d*, attachment of the membrana tympani; *e*, membrana tympani in its ring; *f*, *g*, *h*, malleus; *i*, *k*, incus; *m*, stapes; *n*, vestibule; *p*, superior; *q*, posterior; *r*, horizontal semicircular canals.

4. Anatomy of the Eye, or Organ of Vision.

A. *Appendages of the Eye not directly concerned in Vision.*

In addition to the eyeball proper, with its apparatus of lenses, fluids, and membranes, in which the formation of images occurs, there are various appendages all more or less concerned in protecting the eye, and in enabling it to perform its functions properly and conveniently. These consist of the

orbits, eyebrows, eyelids, conjunctiva, lachrymal apparatus, muscles of the eye, and ocular fascia, with their several blood-vessels and nerves.

The Orbits. These are conical bony recesses, the sides of unequal length, and joined to each other at angles so as to form quadrangular pyramids: seven bones enter into their formation, the frontal, sphenoid, ethmoid, malar, maxillary, unguis, and palate. The axis or central line of the orbits leads obliquely from the apex forwards and upwards and a little downwards. If, therefore, the axes of both orbits be produced, they will diverge considerably in front, but meet rapidly behind, intersecting at the back of the body of the sphenoid bone. These lines are not parallel to the axes of the eyeballs, which lead more directly forwards and are nearly horizontal. The foramina in the orbit are: 1. The *optic*, which transmits the optic nerve, and beneath this the ophthalmic artery. 2. The *foramen lacerum superius* or *sphenoidal fissure*, the larger inner end of which corresponds to the axis of the orbit, and transmits the third, fourth, ophthalmic division of the fifth, and the sixth cerebral, and filaments of the sympathetic nerves. Beneath these the ophthalmic vein escapes from the orbit to join the cavernous sinus. The external part of this foramen is closed by membrane, through which a small artery from the middle meningeal sometimes passes and assists in supplying the lachrymal gland. 3. The *lacerum inferius* or *spheno-maxillary fissure* is in the inferior external angle of the orbit, and transmits small nerves and vessels from the orbit to the zygomatic fossa. 4. *Internal orbital foramina*, generally two, but sometimes more, are in the superior internal angle; the anterior transmits the nasal twig of the ophthalmic nerve; the posterior, the ethmoidal branch of the ophthalmic artery.

1. The Supercilia, or eyebrows, bound the superior eyelids; they correspond to the superciliary ridge of the frontal bone, which partly causes their prominence. The hairs of the eyebrows are mostly directed in a slanting manner outwards, and are placed in two rows, the superior directed downwards and outwards, the inferior upwards and outwards; both rows converge in a median ridge, which causes a greater fulness and an even, regular appearance. The eyebrows are of use in shading the eye from very strong light, and protecting it from particles of dust and from perspiration and other fluids. They can be moved in three directions: upwards, by the occipito-frontalis muscle; downwards, by the orbicularis; downwards and inwards, by the corrugators.

2. Palpebræ, or Eyelids. These are the two movable semilunar curtains, or folds of skin, placed in front of each orbit, convex and rounded, with horizontal wrinkles, and exactly moulded to the eye. The opening between them is called the *palpebral fissure* or *rima*. When the lids are open, they circumscribe an aperture more or less elliptical, on the size of which the apparent magnitude of the eye greatly depends. Its extremities are called *canthi*. The *outer canthus* is an acute angular commissure a little rounded, about a quarter of an inch distant from the edge of the orbit, to which it is attached by a dense fibrous membrane. The *inner canthus* extends for a short distance inwards towards the side of the nose, the edges being a little rounded; externally it presents a small tubercle on

each edge called the *lachrymal papilla*, the point of which exhibits a minute but distinct foramen, the *punctum lachrymale*, which is the commencement of a small canal, the *lachrymal duct*, by which the tears are conveyed into the lachrymal sac and thence into the nose. From between the puncta the palpebral fissure leads inwards and enlarges into a small triangular space, the *lacus lachrymalis*, in the centre of which there is a red papilla, the *lachrymal caruncle*, between the upper and lower lachrymal duct. The upper eyelid is much deeper and more movable than the lower. The free or *ciliary margins* of the palpebræ are thick, firm, and abrupt, cut off horizontally so as to meet closely by flat surfaces.

The palpebræ are composed of skin, areolar tissue, an orbicular muscle, cartilage or fibro-cartilage, with connecting fibrous membrane, glands, and mucous membrane. The upper lid also has a special levator muscle, and the free border of each is fringed with rows of hairs or cilia.

The *skin* is continuous with that of the forehead and cheek, and is of exceedingly delicate texture. The semilunar concentric folds, seen when the eye is open, are effaced when the lids are closed. The *areolar tissue* is very fine and loose, perfectly free from adipose structure.

The *cilia* or *eyelashes* are stiff and strong, and have curved hairs placed in three or four rows in the cutaneous edge of the free margin; all are curved or bent, the superior upwards, the inferior downwards, so that when the lids are closed the convexities only touch, without the hairs becoming entangled with each other. The cilia defend the eye from the admission of particles of dust, minute insects, &c., and can also shade it in too strong a light. Along the posterior or ocular edge of each free border is a row of minute foramina, the openings of the ducts of the Meibomian glands.

The *orbicular* or *sphincter muscle* is the next tissue in the palpebræ; it also extends over the circumference of the orbit, superiorly into the supercilia, and inferiorly into the cheeks. All the fibres are attached into the internal tendon, the *tendo oculi* or *palpebrarum;* this is inserted into the nasal process of the maxillary bone, thence it is directed outwards in front of the lachrymal sac, above its centre, and bifurcates. Each band incloses a lachrymal duct, and is inserted into the inner extremity of each tarsal cartilage beneath the punctum. This muscle closes the lids as a sphincter, by depressing the upper one considerably and raising the lower one very slightly, at the same time drawing it horizontally inwards. It supports the globe of the eye, directs the lachrymal secretion into the puncta, cleans and polishes the surface of the cornea; it also serves to protect the eye from too much light.

The *palpebral* or *tarsal cartilages* are thin elastic plates covered by the orbicularis muscle on the exterior surface. The ciliary margin in each is abrupt and thickened, causing the firmness of the edges of the eyelids. The orbital edge of each is thin, and attached to the base of the orbit by a fibrous expansion termed the *broad ligaments of the tarsus*. The object of these cartilages is to impart strength, pliancy, and elasticity to the palpebræ.

The *Meibomian glands* or follicles appear on the eversion of the palpebræ, as bony, pale yellow parallel ducts, leading from the free margin of each

lid along the ocular surface of the cartilage, and covered by the mucous membrane; their openings are seen with a lens as a row of minute pores behind the cilia. They secrete an unctuous fluid which lubricates the edges of the lid and the cilia, prevents their friction and adhesion when closed, and hinders the overflow of tears when these are secreted in moderate quantity.

The *conjunctiva*, or *internal integument of the palpebræ*, lines these curtains, and connects them with the eye. At the free edge of each lid, it is continuous with the skin. Within the superior lid it ascends, and rises above the cartilage into a cul de sac, the *superior palpebral sinus*, which is loosely connected with the cellular and adipose tissue within the orbit, and is then reflected on the fore part of the sclerotic coat of the eye. It is continued over the cornea as an exceedingly delicate membrane, only separable by previous maceration. From the lower part of the sclerotic, the conjunctiva is reflected on the inner surface of the lower lid, forming the *inferior palpebral sinus*, and extends to the margin. At the inner canthus of the eye, it forms a vertical fold, the *plica semilunaris*. The *caruncula lachrymalis* is a small irregular eminence, placed in the lacus, at the inner canthus of the internal palpebral fissure, internal to the plica semilunaris. It contains a number of minute follicles, which secrete a sebaceous substance which often accumulates in the cornea.

3. Lachrymal Apparatus. This consists of the lachrymal gland and its excretory ducts, the two puncta lachrymalia, the lachrymal canals leading from each into the lachrymal sac, and lastly the nasal duct, leading from the latter into the nose.

The *lachrymal gland* is of a pale reddish color, surrounded by a cellular capsule, situated at the upper and outer aspect of the globe of the eye, a position from which its secretion can most effectually flow over the anterior surface of the globe. It consists of two lobes, a superior or orbital and an inferior or palpebral. Six or eight delicate ducts descend nearly parallel from the gland, and open opposite to its lower border by separate orifices on the inner surface of the upper lid, commencing about half an inch from the outer canthus, and a little above the upper margin of the cartilage. This organ secretes the tears which serve to lubricate the eye-ball, and to dilute the more viscid secretion of the mucous membrane. The lachrymal secretion consists of water, and about one per cent. of chloride of sodium (common salt), with a yellow extractive matter.

The *puncta lachrymalia* are the two small holes in the cartilaginous projections named lachrymal papillæ. They are always open and visible to the naked eye, at the inner extremity of the ciliary margin of each cartilage, and about two lines distant from the inner canthus. Each opening will admit a bristle. They are separated by the caruncula, and each leads into the following.

The *lachrymal canals* are two, a superior and an inferior. The superior ascends from the punctum, then bends downwards to the anterior and outer side of the sac. The lower canal just descends, then ascends and opens into the sac very near to the first.

The *lachrymal sac* is the upper extremity or oval cul de sac of the nasal duct, distinguished from it externally only by a small constriction, and internally by a semilunar fold. It is situated opposite to the middle meatus of the nose, receives the lachrymal secretions from the small ducts, and transmits them to the nose. It is usually filled with adhesive mucus.

The *nasal duct* leads obliquely downwards and outwards from the sac, and opens into the anterior part of the outer side of the roof of the lower meatus of the nose under cover of the inferior turbinated bone. It is about three fourths of an inch long, a little curved, and separated from the antrum by a thin but strong bony lamella. It is a fibro-mucous duct, inclosed in and rather loosely adherent to the bony canal, formed by the maxillary, unguis, and inferior spongy bones.

4. Muscles of the Eye. The orbit of the eye contains seven muscles, the interstices of which are filled with a quantity of soft adipose substance. These muscles are the levator palpebræ, four recti, and two oblique. All these except the inferior oblique arise near or around the apex of the cavity, and thence diverge to their respective insertions. These are situated above the optic nerve, the levator palpebræ, superior oblique, and superior rectus; two are beneath it, the inferior rectus and inferior oblique; and one is at either side, the internal and external rectus.

The *levator palpebræ superioris* is one of the largest and highest muscles in this region. It arises by radiated tendinous fibres from the upper or anterior border of the foramen opticum, and from the fibrous sheath of the optic nerve. It passes forwards in the axis of the orbit, becomes broad, thin, and fleshy, anteriorly bends downwards in front of the eye, and ends in a thin membranous expansion, which is inserted into the convex border of the superior tarsal cartilage, as also into the convexity of the superior palpebral sinus of the conjunctiva, behind or beneath the broad ligament of the tarsus. It serves to elevate the upper eyelid, also to retract its cartilage beneath the edge of the orbit. A branch of the third or motor nerve is distributed to it, which, with the muscle when paralyzed, permits the upper eyelid to droop downwards in front of the eye.

The remaining six muscles are proper to the eye-ball. Four are called straight, and two oblique. By their varied combinations, all the motions of the eye-ball are performed. The *recti* muscles are by no means straight, since all arise from the apex of the orbit, and diverging as they pass forwards, inclose a pyramidal space embracing the greater part of the globe of the eye, and bending a little around the fore part of the eye to reach their insertion. Each rectus muscle, then, represents a curve with its concavity towards the eye-ball. They are each of a triangular form, the apex behind, the base before. All terminate in front by thin tendons which extend to within a few lines of the circumference of the cornea. They are connected together by a cellulo-fibrous tissue named *ocular fascia*. The names assigned to the different recti muscles are *rectus superior*, or *levator oculi; rectus internus*, or *adductor oculi; rectus inferior*, or *depressor oculi;* and *rectus externus*, or *abductor oculi.*

The oblique muscles are two in number, the superior and the inferior.

The *obliquus superior* or *trochleator* arises from the sheath of the optic nerve, and from the inner margin of the optic foramen. It passes forwards and ends in a round tendon, which passes through the cartilaginous pulley attached by a movable fibrous ligament to a depression behind the inner angle of the os frontis: the tendon then passes backwards and outwards, and is inserted into the posterior part of the sclerotic coat between the superior and external recti. In some instances the pulley is bony instead of cartilaginous.

The *inferior oblique* muscle is the shortest of the group, and the only one that is not connected to the apex of the cavity, being situated at the inferior and anterior part of the orbit, behind the lower eye-lid. It arises from a rough ridge within the orbital margin of the superior maxillary bone external to the lachrymal sac, and ends in a broad thin tendon which ascends between the eye and the external rectus, becoming inserted into the posterior external part of the sclerotic. The two oblique muscles are adapted to rotate the eye on its axis. The recti muscles are adapted to change the position of the axis of the eye with reference to the axis of the orbit, and by the combination of the two sets of muscles, the axis of the eye can be turned with ease and precision to any object in front of the body.

5. Blood-vessels of the Orbit. The arteries are the ophthalmic artery and its ramifications, assisted by small vessels from the facial, temporal, and internal maxillary arteries. The *ophthalmic* artery, as the principal, arises from the internal carotid, just after the latter has emerged from the cavernous sinus, and is curving upwards by the side of the anterior clinoid process. It immediately becomes attached to the sheath of the optic nerve, and passing into the orbit, sends off numerous branches to supply the optic apparatus. The principal vein is the *ophthalmic*, which escapes from the orbit by the inner wide portion of the sphenoid fissure; it then enters the cavernous sinus, whence the blood is carried by the petrous sinuses to the internal jugular veins.

6. Nerves of the Eye. The nerves of the eye are large and numerous, no less than four entire nerves and a portion of three others being distributed to this organ. These nerves are the second, third, fourth, and sixth; one division of the fifth, and branches of the seventh or facial, and of the sympathetic. Each of the cerebral nerves arises from a distinct part of the nervous system, and ministers to some distinct and special purpose.

Pl. 131, *fig.* 1, well formed left eye of a middle-aged man, seen from the front: *a b c*, eye-brow; *d*, upper eye-lid; *e r m*, palpebral fissure; *e f g h i*, inner canthus of the eye, with the lacus and the lachrymal caruncle; *k l*, line showing the difference in height between the two canthi of the eye; *m* to *q*, lower eye-lid; *r*, outer canthus; *s t v w*, iris. *Fig.* 2, female eye, for comparison with the male. *Fig.* 39, lateral view of the eye. *Fig.* 3, left eye, as shown during a quiet sleep; *a b c*, eye-brow; *o d e l*, depressed upper eye-lid; *e f*, completely closed rima; *g*, lashes of both lids; *h* to *o*, translucent portion of the eye-lid; *p*, fold of the lower eye-lid. *Fig.* 4, eye-lids removed, and seen from behind: *a*, portion of the orbicularis muscle; *b*, rima palpe-

bræ; *c*, lachrymal gland; *d*, its division into two lobes; *e*, excretory ducts of the lachrymal gland; *f*, their openings; *g*, conjunctiva; *h*, Meibomian glands; *i*, superior punctum lachrymale; *k*, Meibomian glands of the lower eye-lid; *l*, inferior punctum lachrymale; *m*, caruncle. *Fig.* 5, nearly the same view, but magnified: *a*, orbicularis muscle; *b*, rima; *c*, levator palpebræ; *f*, openings of the excretory ducts of the lachrymal glands; *g*, conjunctiva; *h*, Meibomian glands of the upper eye-lid; *i*, portion of the conjunctiva reflected, to lay bare the Meibomian glands; *k*, openings of these glands; *l*, glands of the lower eye-lid. *Fig.* 6, Meibomian glands, highly magnified. *Fig.* 7, inside of the eye-lids, with the puncta lachrymalia. *Fig.* 8, lachrymal apparatus: *a b c d*, upper and lower lachrymal canals; *e f g*, lachrymal sac; *h i*, nasal portion of the lachrymal sac; *k l*, lachrymal glands. *Fig.* 9, muscles of the left eye-ball: $^{1, 2, 3}$, outline of the orbit; ^{4}, pulley for the tendon of the trochleator or superior oblique muscle; ^{5}, eye-ball; $^{6, 7}$, optic nerve; *a* to *e*, levator palpebræ superioris; *f g*, superior, *h i k*, external rectus; *l*, inferior oblique; *m*, inferior rectus; *n o*, internal rectus; *p* to *s*, superior oblique muscle of the eye. *Fig.* 10, the same view, the levator palpebræ removed: $^{6, 7}$, optic nerve; *g*, superior rectus removed; *h* to *o*, the same as in the preceding figure; *p* to *u*, superior oblique muscle. *Fig.* 11, *a b c*, internal rectus; *d e f*, inferior, *g h i*, external rectus; *k l m*, inferior oblique muscle. *Fig.* 12, nerves belonging to the eye: ^{2}, optic nerve; ^{3}, third cerebral nerve or oculomotor; *x*, branch from it to the internal rectus muscle; ^{4}, fourth cerebral nerve; *a*, branch from the fifth pair; ^{5}, fifth cerebral nerve; A, central extremity; B, plexiform swelling; C, first branch; D, second do.; E, third do.; FF, foramen ovale; G, foramen rotundum; *a*, communicating branch between the fourth and fifth nerves; *b* to *i*, frontal branches; *k* to *y*, distribution of the lachrymal nerve; $^{6, 6', 6''}$, sixth cerebral nerve. *Fig.* 13, ramifications of the third pair of nerves, and the ciliary ganglion: A, superior rectus muscle; B, B, levator palpebræ; ^{3}, third cerebral nerve; *a b*, small upper branch; *c*, branch to the superior rectus; *d*, branch to the levator palpebræ; *e*, inferior branch; *f*, branch to the inferior rectus; *g*, lower branch; *h*, branch to the ophthalmic ganglion; *ii*, branches to the inferior oblique muscle; *kkk lll m*, branches proceeding from the ophthalmic ganglion (ciliary nerves); ^{5}, fifth cerebral nerve; *n*, first branch; *o p q r*, four branches of the latter; *t*, branch to the nares; *u*, thread connecting it to the nerve of the superior rectus; *v*, branch to the ophthalmic ganglion; ^{6} *w*, sixth cerebral nerve. *Fig.* 14, nerve of the inferior rectus muscle; branch from the fifth and sixth pairs to the nares: A, fifth cerebral nerve; B, Casserian ganglion; C, first, D, second, E, third branches of do.; F, F, lesser portion; G, superior oblique muscle; *b* to *v*, the same as in the preceding figure; *tz*, inferior trochleator nerve; *α*, sixth cerebral nerve; *ββ*, branches of the sixth nerve to the carotid plexus; *η*, branch to the external rectus. *Fig.* 15, ramifications of the left ophthalmic artery: A to D, orbit; E, levator palbebræ, cut through and reflected; F G, superior rectus; H, internal rectus; K, external rectus; L, optic nerve; M, eye-ball; N O P, carotid artery; Q R, ophthalmic artery; *a b*, ciliary arteries; *c*, artery to the lachrymal gland; *d*, ciliary branch of do.; *e*, feeble branch to the external rectus;

f, branch to the inferior oblique muscle; *ff*, stronger branch to the external rectus muscle; *g h i*, separation of the lachrymal artery, and to the lachrymal gland and upper eye-lid. *Fig.* 16, veins of the eye: A B C, orbits; D E, eye-ball; F, optic nerve; G H, levator palpebræ; K, superior rectus; *k*, superior oblique muscles; L, pulley of do.; M N, external rectus, cut through; O, inferior rectus; *a* to *m*, branches to the facial vein; *o p*, ophthalmic vein; *q r s*, ophthalmic branch of the facial vein; *t t*, vein from the superior rectus; *u u*, superior ciliary vein; *v v w w*, lachrymal gland vein; *x*, posterior nasal vein; *yy*, veins from the sheath of the optic nerve.

B. The Eye-Ball.

The ball or globe of the eye, or the eye proper, is placed at the anterior and internal part of the orbit, behind the conjunctiva, surrounded by fascia, muscles, vessels, nerves, and adipose substance, and retained in its situation by the optic nerve, the recti and superior oblique muscles, which support or suspend it in the surrounding fat, and admit of its free and easy motions. It is small in comparison with the cavity which contains it. In some persons it appears more prominent than in others; the variety in this respect depends partly on the amount of adeps in the orbit, and partly on the size of the palpebral opening; it is also absolutely larger in some than in others. The eye is nearly spherical, and about one inch in diameter, but, in consequence of the slight projection of the cornea, which is a segment of a smaller sphere superadded to the larger one formed by the sclerotic, the antero-posterior axis is one or two lines longer than the transverse. A transverse section, dividing it into an upper and lower half, or a vertical section, dividing it into a right and left portion, will exhibit an oval outline; but a perpendicular section, cutting it into an anterior and posterior half, will exhibit the circular form. The long axes of the eyes are nearly parallel to each other, and therefore not so to that of each orbit. The eye is a hollow globe, the wall or shell of which is composed of different membranes or tunics, and the cavity is filled by transparent fluids or humors for optical purposes. The *coats* are three, the sclerotic, the choroid, and the retina; these fit accurately one within the other, and are in close apposition. The first is called sclerotic; it is a fibrous membrane, for the protection and maintenance of the form of the organ; it invests the posterior four fifths, and presents a circular opening in front, into which the transparent cornea is inserted, which completes the anterior fifth: the cornea and fore part of the sclerotic are also covered by the conjunctiva. Within the sclerotic is the second tunic, the choroid, which is extremely vascular, and contains the nutrient vessels and nerves; it also secretes the brown or black pigment, which deeply stains the interior of the globe and the back of the iris, to prevent the reflection of the rays of light from the bottom and sides of the organ back again through the retina. In the anterior part of this tunic there is also a circular opening or deficiency, into which the iris is fitted, as the cornea is into the sclerotic. External to the circumference of the iris the choroid is intimately attached to the sclerotic by the ciliary band or ligament; and internally and behind the iris it is connected to the membrane

of the vitreous humor by a series of folds, called ciliary processes, arranged in a circular form around the margin of the crystalline lens. The third, or innermost tunic, is the retina, the delicate expansion of the optic nerve; this extends from the entrance of the nerve, at the back of the eye, all around the interior of the choroid membrane, and terminates in front about two lines behind the anterior border of the latter; this is the essential part of the organ, being endowed with sensibility to light; all the other parts may be considered as subordinate to it. The *humors* of the eye are the aqueous, the crystalline lens, and the vitreous; these, though of different densities, and inclosed in membranous capsules, are all transparent, and exactly fill the globe. The aqueous fluid occupies the space between the cornea and the lens; the iris floats and moves in this fluid, and divides the space into two chambers, the anterior and posterior. The anterior is between the cornea and iris, and the posterior between the iris and the lens and vitreous humor; this space is very small, and both communicate freely through the pupil, or the circular aperture in the centre of the iris. All the posterior region of the eye is filled by the vitreous humor, a soft, gelatinous, transparent mass, composed of the most delicate cellular membrane, the cells filled with fluid. In a depression on the fore part of this substance, and behind the pupil and iris, is placed the crystalline fluid or humor, of greater density than either of the other two, and of the form of a double convex lens. We shall next proceed to the examination of these parts of the eye, in greater detail.

1. Tunica Sclerotica. This, together with the cornea in front, forms the external coat or case of the eye, and extends from the optic nerve to the circumference of the cornea; it is a dense, opake, fibrous membrane, very strong and inelastic, preserving the figure of the organ and protecting from injury and pressure the delicate structure within. Near the entrance of the optic nerve it is pierced by numerous small foramina, for the short ciliary nerves and vessels; more anteriorly, by small oblique canals for the long ciliary; and a little behind the transverse axis there are four or six larger canals for the exit of veins. The internal surface of the sclerotic is in contact with the choroid membrane, and is stained by the brown pigment. When washed clean it presents a smooth glossy appearance, owing partly to the presence of a very fine serous-like lamina. The thickness of the sclerotic is greatest posteriorly, about the optic nerve; thence it thins out towards the centre. The optic nerve perforates the sclerotic about a line and a half internal to the antero-posterior axis. As the nerve approaches this point, it is suddenly constricted; its fibrous sheath of dura mater is intimately united to the sclerotic, and the contracted nerve passes through a small aperture in the membrane which appears traversed by fibres, and has received the name of *lamina cribrosa*. When the nerve is squeezed, a central dark point will be observed in a section, called the *porus opticus*, and showing the position of the cerebral artery of the retina.

2. The Cornea forms the anterior fifth of the eyeball, and completes the external case, by joining on to the sclerotic; it projects beyond the level

of the sclerotic, being the segment of a smaller sphere engrafted on the larger one formed by that membrane. It is perfectly smooth and transparent, circular in form, although the transverse diameter is slightly larger than the vertical. In man it is a concavo-convex lens of slight refracting power, owing to the fact of its greater thickness in the centre than at the edges. The margins of the sclerotic are bevelled off obliquely, the outer lamina extending further than the inner; between the edges there is a shallow groove, into which the cornea is fitted like a crystal in a watch. The cornea consists of several layers, some of these exceedingly delicate. Exteriorly there is a fine *epithelial lamina*, constituted by the prolongation of the conjunctiva. This becomes opake after death, causing the peculiar film over the eye. Next comes the *cornea* proper, consisting of transparent, soft, flexible laminæ, connected together by delicate areolar tissue. Posterior to the proper laminated cornea is a thin, strong, elastic, cartilaginous lamina, the *membrane of Demours;* it is perfectly transparent, and is placed between the cornea and the membrane of the aqueous humor. It extends beyond the proper cornea, and fits in by a well defined margin between the sclerotic and the ciliary ligament. The fourth layer of the cornea is the membrane or *capsule of the aqueous humor*, a tissue of exquisite delicacy.

The *choroid coat* is the second tunic of the eyeball, and is so named from an imaginary resemblance to the chorion of the gravid uterus. It is a soft membrane of a dark brown color, extending from the optic nerves as far forwards as the ciliary ligament, which is internal to the line of junction between the cornea and sclerotic, and external to the iris. This ligament and the iris may be considered as appendages to it. It is pierced posteriorly by an annular foramen for the passage of the optic nerve; anteriorly it presents a large opening for the iris. The choroid is extremely vascular and organized, and serves not only as a connecting medium between different parts of the organ, but also for conducting vessels and nerves to the interior, especially to the iris; it also secretes the dark pigment of the eye. This is deposited throughout its substance, more thickly, however, internally; the sclerotic is stained by it, but not the retina. This peculiar secretion is intended to darken the interior of the eye, as is done in the interior of optical instruments, to absorb the rays of light and to prevent their being reflected back again to the retina.

3. The Ciliary Ligament is a soft, spongy, fibro-cellular, annular band, of a greyish white color, not stained by pigment. It is continuous with the anterior margin of the choroid, internal to the line of junction between the cornea and sclerotic. The iris is inserted into its external border, and from its anterior aspect are continued the ciliary processes or folds of the choroid membrane. It thus serves as a common central medium to connect the various tissues of the eye.

4. Ciliary Processes, or corpus ciliare, are delicate folds or plaits of the choroid membrane, extending from within the ciliary ligament to the back part of the iris, and thence along the fore part of the vitreous humor to near the circumference of the crystalline lens; the entire series resembles the disk of a composite flower.

5. The Iris is the circular, vertical partition dividing the intervening space which contains the aqueous humor into two chambers, an anterior and a posterior, these communicating by the central circular aperture in the iris named the *pupil*. This opening is circular in the main, and a little nearer to the nasal than to the temporal side of the iris; its size varies with the distance of the object in view, the sensibility of the retina, and the intensity of the light. There is often a correspondence in color between the iris and the hair. The posterior surface is coated with a thick lamina of dark pigment named *uvea*, from a fancied resemblance to a ripe purple grape. The iris is highly organized, and receives its blood posteriorly from the long ciliary arteries, and anteriorly from the ophthalmic. The nerves of the iris are derived from the ophthalmic ganglion. The structure of the iris is pretty generally considered to be muscular, the exceedingly minute fibres being arranged in two series, one radiated, the other circular, concentric with the pupil. When enlargement is necessary, the sphincter or circular fibres relax, and the radiated acting from the circumference to the centre approximate the inner margin of the iris to the outer, the reverse taking place when the aperture or pupil is to be diminished.

During the greater part of uterine life the pupil of the fœtus is closed by the *membrana pupillaris*, a delicate membrane filling up the aperture of the pupil, and completely separating the anterior from the posterior chamber. It actually consists of two thin laminæ, extending from the surface of the iris. It is most distinct about the fifth month, and becomes absorbed towards the period of birth.

6. The Retina is the third or innermost, or nervous tunic of the eye, and is in immediate contact with the vitreous humor which distends the posterior part of the globe. During life it is transparent, but soon becomes clouded. It is the expansion of the optic nerve into a membrane forming the portion of a sphere, and extending between the choroid and the vitreous humor to within about one eighth of an inch of the ciliary ligament. The optic nerve pierces the posterior part of the globe about a line and a half internal to the centre. About a line and a half to the inside of the entrance of the optic nerve, and in the part of the retina which would be pierced by the imaginary antero-posterior axis of the eye, there is a small circular or oval spot with a dark centre and a yellowish border. This has been called the *foramen of Sœmmering* or the *punctum aureum*.

The retina consists of three laminæ, each differing in texture and function. The exterior is the *tunica serosa* or *Jacob's membrane;* it supports the nervous tissue and separates it from the pigmentary surface of the choroid. The internal is a *vascular layer*, composed of the capillary ramifications of the centralis artery and vein. The *middle layer* is the expanded medullary or fibrous substance of the optic nerve.

The cavity of the eye is occupied by refracting media, the humors differing from each other; these are the aqueous, the crystalline, and the vitreous, and are placed in this order between the cornea and the optic nerve.

7. The Aqueous Humor is a perfectly colorless liquid, occupying the interval between the cornea and the lens, and inclosed by a fine secreting

membrane or capsule. It differs but little from water in specific gravity and refractive power. Chemically it consists of about ninety-eight parts of water and two of chloride of sodium, with a trace of albumen. The space occupied by this humor is divided into two apartments by the iris, anterior and posterior.

8. THE CRYSTALLINE LENS is a transparent, double convex lens, the anterior convexity less than the posterior. The former forms part of a circle whose diameter is seven or eight lines in length, the latter one of four or five lines. Its convexity varies, however, with age. A perfectly transparent elastic capsule invests the lens proper. On opening the anterior part of the capsule of an eye long dead, a liquid escapes, known as liquor Morgagnii. This accumulation of liquid in all probability does not exist in the recent eye. The crystalline lens itself is of quite complicated structure. When boiled it can be separated into concentric layers, of which the exterior are soft, the internal increasing in hardness to the central nucleus. These laminæ appear to consist of parallel fibres united by finely serrated or toothed margins. During the separation of these laminæ, a moderate pressure will cause the whole to part into three triangular or wedge-shaped segments. In the recent lens, the density of the layers increases from the surface towards the centre, this involving a corresponding increase in refracting power. Consequently, rays of light falling on the exterior of the lens, will be refracted to the same focus as those passing through the centre, meeting there a more highly refracting medium. Certain defects of vision depend greatly on abnormalities of the crystalline lens. Thus a convexity greater than usual produces short-sightedness by causing the rays of light to converge to a focus in front of the retina, thus necessitating an unusual approximation of an object to the eye. In long-sightedness, the lens being less convex than usual, the rays tend to a focus behind the retina, and to bring this point of convergence on the retina, the object has to be held at a greater distance.

9. THE VITREOUS HUMOR, OR THE HYALOID BODY, fills the posterior three fourths of the globe, and is in contact with the whole of the inner surface of the retina. Anteriorly and centrally the crystalline lens is imbedded in it, and more externally the ciliary processes are attached to it. In the adult it is perfectly transparent, and consists of a membranous capsule and areolar tissue secreting and inclosing a fluid like water. The hyaloid membrane or capsule not only incloses the humor, but sends inwards numerous processes, which join each other, and form a fine areolar or cellular tissue, in the interstices of which the fluid is confined. These cells all communicate with each other, as a single puncture will permit the gradual discharge of all the fluid. The vitreous body is traversed by a small artery from the centralis retinæ, extending to the capsule of the lens. The vascular layer of the retina also in all probability sends into it vessels and nerves.

From the preceding description it must appear that the eye is not only of complete structure and delicate organization, but is also a refined optical instrument. The rays of light proceeding from any object strike

upon the surface of the cornea, which being convex and much more dense than air, refracts them, and causes them to converge towards a distant focus. In passing through the anterior chamber, this convergence is slightly counteracted, and the degree of refraction is about equal to that which would have occurred had they impinged at once upon the convex surface of the aqueous humor, supposing the cornea not to have been interposed. Much of the light that traverses this fluid falls upon the iris, which, like the stop or diaphragm in any optical instrument, excludes it, and this light is reflected back again through the cornea. Hence we see the fibrous texture and variegated color of the iris when we look upon the eye of another. Those pencils of rays only which pass through the pupil are subservient to vision. As these pass through the lens they undergo two refractions, because this medium is convex on both surfaces, and is more dense than either the aqueous or vitreous humor. These refractions increase the convergence of the rays, and bring them to their proper focus upon the sentient surface of the retina, on which is formed an accurate image of the various external objects from which the rays of light have been received. This image is inverted. What is above in the object is below in the image. The right side of the object is to the left, and the left to the right, while the relative position of its different parts remains the same. But as all surrounding objects, if seen, must be equally reversed, the relative position of all objects, therefore, remains unchanged, and there can be no comparison between what is erect and what is inverted, and, therefore, the sense acquires a correct idea of the position of objects. The fact, however, of our seeing objects erect, notwithstanding their images are inverted on the retina, as also that of single vision, from the simultaneous action of both eyes, and many other phenomena, has given rise to some interesting inquiries and to much speculation respecting the functions of the retina and optic nerves.

As the accurate convergence of all these pencils of rays to their respective foci upon the retina is necessary for the formation of a perfect image, and for clear and distinct vision, certain nice adjustments in the apparatus are required, and have accordingly been supplied, and which in artificial optical instruments are attained with difficulty by mechanical skill. An image of an object, formed by a simple refracting medium, is liable to certain imperfections or aberrations of light. These are principally three, and are technically termed, first, aberration from sphericity; second, from parallax; and, third, chromatic aberration. Each of these we shall briefly explain, with a view of considering how they are obviated in the living eye.

Aberration from sphericity arises from this cause: a refracting spherical surface does not unite the parallel or diverging rays of a pencil exactly into one focus, because the lateral rays converge sooner than the central; hence arises a certain degree of confusion, which requires much attention to correct in the construction of the microscope or telescope. This correction is effected in the eye partly by the iris shutting off all circumferential rays, and partly by the form and texture of the lens. Its surfaces are not

spherical, but elliptical, and it is more convex posteriorly than in front. Its density also increases from the surface to the centre, and, as the refractive power is proportioned to the density of the medium, so the rays which pass through and near the centre are brought to a focus sooner, and thus accord with those which are refracted more externally, and thereby that defect is obviated which occurs in lenses of uniform density.

Aberration from parallax may be thus explained. When the object viewed is very distant, the rays of light from it may be considered as nearly parallel; but, when the object is very near, the rays from it diverge considerably in their course to the eye. The effect of refraction on the distant or parallel rays is to bring them to a focus very near the lens; but the near or diverging rays are collected into their focus at a greater distance from it. The more remote the object, the nearer will the focus be to the lens, and for every distance of an object there is a corresponding focal distance behind the lens. If, therefore, the eye be adapted for vision at one particular distance, the images on the retina of objects at any other distance ought to be confused, because the foci will be formed either before or behind the retina. In the latter case this membrane will interrupt the rays in their course, and in the former it will not receive them until they have crossed each other in passing through their focus. This optical defect is counteracted by a power which the eye possesses, named *adjustment*, or accommodating itself to vision at different distances. The immediate agency in this power is not exactly ascertained, but most probably it depends on a vital energy of some of the textures in the globe. It has been ascribed by some to the fibres of the lens being muscular, and capable of altering its form, density, and distance from the retina; by others to a change in the convexity of the cornea, or to an alteration in the form of the globe by the compression of the surrounding muscles, or to a change in the position of the lens through the action of the iris and ciliary body, or through the contraction or erection of the ciliary processes.

Chromatic aberration depends upon the fact that rays of white light are composed of differently colored rays, red, orange, blue, &c., which are partly separated or dispersed by refracting media, and, as some colored rays are more refrangible than others, they will converge sooner; thus blue and violet are more refrangible than red or orange, and will sooner be brought to a focus, and thus the distinctness of the image will be impaired or confused, and fringed with different tints. This defect, which is termed chromatic aberration, is obviated in the eye by the employment of several refracting media, each of different density, and even of different chemical composition. Thus the lens has two unequally convex surfaces, each of which differs in density from its more central portions; the cornea and aqueous fluid form a refracting medium of different consistence from the lens or vitreous humor, and it is probable that the dispersive power of these may be disproportionate to their refracting effect, whereby an achromatic combination is established in the eye, as is effected in optical instruments, by combining lenses of different materials; we are not, however, to conclude that the eye is perfectly achromatic.

The two well known defects in vision, *myopia* and *presbyopia*, depend either upon some peculiarity in the refracting media, or upon a deficiency or weakness in the power of adjusting or accommodating the eye to vision at different distances. Myopia, or near-sightedness, may be caused by too great convexity of the cornea or lens, and is most common in early and middle life; the rays from a near object meet in their focus on the retina, and produce a distinct image; but the rays from a distant object, being nearly parallel, are more easily brought to a focus, and, therefore, meet before the retina, and only form undefined spectra upon it. The defect is partly corrected by means of a concave glass of suitable curvature; this causes the rays to become more divergent; therefore, they converge less quickly, and form their focus upon the retina. Presbyopia, or far-sightedness, is more common in old age, when the cornea and lens are less convex than in youth; the rays from distant objects, being nearly parallel, are refracted to a proper focus upon the retina; but those from near objects are not refracted soon enough, and, therefore, their forcus being formed behind the retina, they do not form the image upon the nerve. This defect is remedied by a convex glass, which will cause the convergence of the rays from a near object, and bring them more rapidly to a focus, so as to form the image upon the retina, instead of behind it.

Pl. 131, *fig.* 17, anterior half of a section of the eyeball: *a*, sclerotic coat; *b*, lamina fusca; *c*, choroid coat; *d*, pigmentum nigrum; *e e f*, retina; *g h*, ciliary processes; *i k l*, crystalline lens. *Fig.* 19, posterior half of the same eye: *a–d*, as in the preceding figure; *e–k*, retina; *l*, entrance of the optic nerve. *Fig.* 19, retina: *b*, foramen centrale; *c*, its yellow border; *d e f*, section of the optic nerve; *g h i*, three branches of the central vessels. *Fig.* 20, anterior view of the retina and of the vitreous humor: *a b*, retina; *c b*, corona ciliaris about the lens; *c d*, lens; *d*, foramen centrale; *e e*, blood-vessels of the retina. *Fig.* 21, exterior of the retina: *b*, foramen centrale; *c d*, optic nerve; *e f g*, corona ciliaris of the vitreous humor; *h i*, arteries. *Fig.* 22, choroid coat: *a b*, optic nerve; *c–f*, portion of the sclerotic; *g–k*, choroid coat; *m*, long ciliary artery; *n*, long ciliary nerve; *o*, long internal ciliary nerve; *p p*, long and short vessels of the choroid; *q q*, ciliary nerves; *r*, *s*, *t*, vasa vorticosa. *Fig.* 23, the same from the other side: *a b*, optic nerve; *c–f*, sclerotic; *g h i*, iris; *m*, vasa vorticosa; *n p*, ciliary nerves. *Fig.* 24, inner surface of the retina: *a*, foramen centrale; *b b*, folds of the retina; *c*, arteria centralis; *c d e e*, four branches of do. *Fig.* 25, the vessels of the retina magnified. *Fig.* 26, distribution of the vessels of the iris magnified: *a b c*, vasa vorticosa; *f h*, arteries of the iris; *k k*, their retiform distribution; *m n*, layer; *l o*, smaller circle of vessels. *Fig.* 27, nerves of the iris magnified: *e b*, branches of the ciliary nerves; *b b*, distribution on the border of the iris. *Fig.* 28, vessels of the iris and of the membrana pupillaris magnified. *Fig.* 29, lens of a newborn child in profile; *fig.* 30, lens of a child six years old; *fig.* 31, do. of a grown man; *fig.* 32, section of a lens preserved in alcohol to show its laminated structure; *fig.* 33, lens hardened by alcohol and split into several segments; *fig.* 34, exfoliated lens; *fig.* 35 *a*, three layers of a segment of a lens; *fig.*

35 *b*, an exfoliating lens magnified, showing its tendency to divide into three segments. *Fig.* 36 *a b*, iris, choroid, and pupillary membrane of a seven months' fœtus with their vessels magnified: *a b c*, choroid; *d e*, membrana pupillaris; *f g*, long ciliary artery; [1 to 5], vasa vorticosa of the choroid. *Fig.* 37, the same figure nearly of natural size. *Fig.* 40, vertical section of the left eye, the eyelids closed. *Fig.* 41, do. the eyelids opened. *Fig.* 42, outline references to the two preceding figures: A—H, upper wall of the orbit; M—Q, lower wall of do.; R—V, dura mater; W—Z, forehead; *a–d*, eyebrows; *e–w*, upper eyelid; *a–q*, lower eyelid; [1 to 11], muscles of the eye; [12 to 18], optic nerve; [19 to 21], vessels and nerves of the eye; [22, 22], axis of the eyeball; [23], its largest transverse diameter; [28], centralis retinæ; [29], sclerotic coat; [30], pigmentum nigrum; [31 to 37], choroid coat; [38, 39], portion of the choroid uncovered by the retina; [36, 37], iris; [39 to 41], retina; [42 to 46], lens. *Fig.* 43, horizontal section of the two orbits and of one eye: *α α β β*, frontal sinuses; *γ γ*, fat in the orbits: *a a b b*, section of the ethmoid bone; *c c*, *d d*, *e e*, ethmoidal cells; *g*, sella turcica; *h h*, section of sphenoid bone; *i i*, sheath of the optic nerve; *k k l l*, section of the zygomatic bone; *m m*, section of frontal bone; *r r*, optic nerve; *s*, external, *t*, internal rectus muscle; *u*, eyeball of the right side; *v*, do. of the left in section; *w w*, sclerotic; *x x*, the choroid; *y y*, cornea; *z z z z*, coverings of the eye.

The remaining organ of sense, the tongue with its physiology, will be more conveniently examined in connexion with the alimentary canal. We proceed next to the consideration of the organs of respiration and voice.

VI. ORGANS OF RESPIRATION AND VOICE.

The larynx, trachea, and lungs, constitute an apparatus, by means of which the oxygen of the atmosphere is introduced into the system and carbonic acid gas is exhaled. They are at the same time adapted to the production of sounds. We may even compare the lungs to the bellows of a musical instrument, the trachea to the air pipe, and the larynx to the tongue work.

1. The Larynx.

The larynx surmounts the upper extremity of the respiratory passages, with which it communicates below as it does with the pharynx above; it is composed of a complicated apparatus of several cartilages, muscles, and ligaments, which constitnte the organ of voice, and is suspended by muscles and ligaments from the os hyoides.

1. The Os Hyoides consists of five parts. The middle, or *body*, is concave posteriorly and convex anteriorly; on each side a *cornu* passes off, giving attachment to muscles above and below; and where each cornu

joins the body, there is a small process called the appendix, which ascends obliquely backwards, and gives attachment to the stylo-hyoid muscle and ligament. When, as sometimes happens, this ligament is ossified, the os hyoides becomes attached directly to the cranium.

2. Cartilages of the Larynx. Four true or perfect, and four false or imperfect cartilages enter into the composition of the larynx. The former are the thyroid, cricoid, and two arytenoid; the latter are the two corpora cuneiforma, and the appendices or cornicula of the arytenoid cartilages; there is also one fibro-cartilage, the epiglottis.

The *thyroid cartilage* is placed at the anterior and lateral parts of the larynx. It is composed of two broad lateral plates, connected in an anterior median prominence, known as the *pomum Adami* or *Adam's apple*, and larger in the male than in the female. The posterior surface of the pomum gives attachment to the ligament of the epiglottis and to the chordæ vocales.

The *cricoid*, or annular cartilage, forms the lower part of the larynx. The inferior edge is nearly circular and horizontal, and gives attachment to the first ring of the trachea; the superior margin is oblique, and separated from the thyroid cartilage by the crico-thyroid ligament.

The *arytenoid cartilages* are situated vertically on the articulating surfaces on the upper and posterior border of the cricoid. The base of each presents two processes, one for the attachment of the crico-arytenoid muscle, the other for the insertion of the inferior chorda vocalis. The apex of each arytenoid inclines a little backwards, and is surmounted by the *appendix*, or *corniculum*. The internal or opposed sides of the arytenoid cartilages are smooth, and covered by mucous membrane, so as to admit of their approximation.

The *epiglottis* stands behind the base of the tongue, nearly erect in front of the opening of the glottis, over which it can be bent almost horizontally, so as to cover this opening during deglutition. In form it is somewhat triangular or oval, so as to resemble a cordate leaf, with the edges slightly curled.

The larynx is articulated or connected to the os hyoides by three *hyo-thyroid* ligaments, one middle and two lateral. The *thyro-arytenoid* ligaments, or *chordæ vocales*, are four in number, two on each side, a superior and an inferior. The ligaments of the epiglottis are the *thyro-epiglottidean*, the *hyo-epiglottidean*, and the *frænum epiglottidis*. This latter, however, is only a fold of mucous membrane, connecting the epiglottis with the tongue.

3. Muscles of the Larynx. The muscles of the larynx are symmetrical; they are found on the front, sides, and back part. Those on the fore part are the thyro-hyoid and crico-thyroid; those on each side are the thyro and lateral crico-arytenoid; the muscles of the back part are the arytenoid and the posterior crico-arytenoid.

The openings of the larynx are two, the superior or the glottis, and the inferior or the tracheal. The *superior opening*, or the *glottis*, is at the lower and anterior part of the pharynx, behind the epiglottis and rather beneath the tongue. It is of a triangular form, the base anteriorly formed

by the epiglottis: the sides are composed of the aryteno-epiglottidean folds of mucous membrane; and the apex, which is posteriorly notched or bifid, is formed by the appendices of the arytenoid cartilages. The *inferior opening* of the larynx is always free, and nearly a perfect circle, formed by the lower border of the cricoid cartilage, which is connected to and continuous with the trachea.

Intermediate between these two openings, and nearly midway within the larynx, is a very remarkable slit-like narrowing of its cavity, named the *rima glottidis.* This, the seat of the vocal function, is bounded laterally by the chordæ vocales. Its form is variable, and depends on muscular action, being subject to change in shape and size during every act of respiration, voice, and speech. Immediately above the true chordæ vocales, the larynx presents on each side a lateral dilatation, called the *ventricle* or *sinus of the larynx.* This space is bounded by the semilunar folds known as the false or superior chordæ vocales. From each ventricle the mucous membrane is prolonged upwards in a thimble-like form, constituting a pouch, the *sacculus laryngis.*

The arteries which supply the larynx are derived from the superior and inferior thyroid, the former a branch of the external carotid, the latter of the subclavian. The laryngeal nerves are four in number, a superior and an inferior on each side.

Pl. 129, *fig.* 32, thyroid cartilage; *fig.* 33, cricoid do.; *fig.* 34, arytenoid do.; *fig.* 35, epiglottis; *fig.* 36, section of the larynx: [1], upper, [2], lower vocal cord; [3], ventricle. *Fig.* 37, larynx from before: [1], os hyoides; [2], ligament connecting the os hyoides with the thyroid cartilage; [3], thyroid cartilage; [4], ligament between the thyroid and the cricoid cartilage; [5], cricoid cartilage. *Fig.* 38, larynx from behind: [1], glottis and epiglottis; [2, 3], ventricles.

Pl. 127, *fig.* 5[7], transverse and oblique arytenoid muscles. *Fig.* 8, larynx from the left side, one half of the thyroid cartilage removed: [1], posterior crico-arytenoid muscle; [2], lateral do.; [3], thyro-arytenoid muscle; [4], muscles of the epiglottis.

2. The Trachea.

The trachea, continuous inferiorly with the larynx, is a tube composed of from sixteen to twenty-six C-shaped cartilaginous rings, open posteriorly. It commences opposite to the fifth cervical vertebra, and descends to about the third dorsal, where it divides into two branches, called *bronchi*, one of which passes to each lung, and there again subdivides. The right bronchus, shorter and broader, extends for an inch before it divides into three branches. The left bronchus, about an inch longer, sinks into the lung on the left side, below the corresponding pulmonary artery, and opposite the fifth dorsal vertebra. The cartilaginous rings determine the shape and diameter of the trachea, but do not lie in immediate contact, being separated and connected by elastic fibrous ligaments, by which the elongation and contraction of the tube are rendered possible. The posterior portion of the trachea corresponding

to the gaps in the cartilaginous rings, is occupied by a layer of long yellow elastic fibre, a transverse muscular layer, and a mucous layer consisting of basement membrane and epithelium. This posterior soft portion, in immediate contact with the anterior of the œsophagus, readily yields to the pressure of the food passing down the latter tube. The entire length of the trachea amounts to about four or five inches, and on the exterior circumference of the bronchi are seen numerous lymphatic glands filled with a black pigment, and called *glandulæ bronchiales.*

Pl. 129, *fig.* 37, trachea and its branches from before: [6], trachea; [7, 8], cartilaginous rings; [9], yellow elastic fibres; [10], right, [11], left bronchus, with their ramifications. *Fig.* 38, posterior view of the trachea: [4], yellow elastic fibres, with their glandular granules; [5], muscular layer, composed of transverse fibres; [6, 7], soft elastic longitudinal fibres, strengthening the mucous membrane, [8].

3. The Lungs.

The lungs, *pulmones*, constitute two conical spongy and elastic bags, occupying, with the heart between them, the cavity of the thorax. The color of the lungs varies, in different parts and at different times, between bright red and dark purple. Their weight amounts in the male to about two and a half pounds, in the female to about two pounds. Each lung forms a cone, with the broad base resting on the diaphragm, the apex being directed upwards. On the inner opposed faces of each lung is a shallow depression into which the bronchi and vessels enter and emerge. The right lung is divided by a fissure, nearly two inches deep, into three, and the left into two lobes. Each lobe exhibits externally a great number of small angular spaces, bounded by darker lines. Each bronchus, on reaching the lungs, divides into as many branches as there are lobes, and these, entering the lobes, subdivide and bifurcate again and again, until the exceedingly minute ramifications end in small air cells, which in the adult probably communicate with each other. On inflating the lungs, these cells will become dilated, and project on the surface in small mammillary or botryoidal swellings. The bronchi, as they penetrate into the lungs, gradually lose their cartilaginous element, until finally they consist of a soft membranous tube, which ends in the cells above referred to, the number of which has been estimated at seventeen or eighteen hundred millions.

The *pulmonary artery*, which conducts venous blood from the right ventricle of the heart, follows all the ramifications of the bronchi, and on the air-cells breaks up into a very delicate vascular plexus, from which the *pulmonary veins* take their origin. The venous blood circulating through this network of vessels absorbs oxygen from the air with which it is brought into contact by means of the air vessels. It then changes color, giving up a portion of carbonic acid and water. This change effected, it returns through four veins, two for each lung, to the left auricle. These vessels have nothing to do with the nourishment of the lungs themselves, this office

being performed by the small bronchial arteries which proceed directly from the aorta, and from independent plexuses in the lungs which yet communicate with those of the pulmonary artery. The returning bronchial veins, too, lead partly to the superior vena cava and partly to the pulmonary veins, so that there is always a small quantity of black blood mixed with the arterial in the left auricle. The nerves destined to the lungs proceed from the vagus and sympathetic. The lungs have comparatively little sensibility, as even in extensive pulmonary diseases but little pain is felt.

Pl. 130, *fig.* 4, larynx, trachea, pericardium, and lungs, from before: [1], larynx; [2], trachea; [3, 4], lungs; [5], pericardium; [6], superior vena cava; [7], arteria innominata; [8], left carotid artery; [9], left subclavian artery.

The organs contained within the thoracic cavity are inclosed by three completely closed serous sacs, the two pleuræ and the pericardium. The latter has already been described with the heart. Each *pleura* is a short sac of a conical shape, and contains only the serous vapor it exhales; although the lung appears within the cavity, it is really external to it or behind it. That portion of each which invests the lungs is called *pleura pulmonalis*, that connected with the parietes of the thorax being the *pleura costalis* or *parietalis*. The relations of the lungs to the pleura may be better understood by supposing the latter at first to occupy the thorax exclusively. They will then constitute two bags, in contact with each other by their inner and opposed faces. If now the lungs are considered to be developed on the outside of the opposed surfaces of each bag, they will force this out towards the exterior, and finally connect each bag into two contiguous laminæ in contact with each other, the one the costal and the other the pulmonary pleura. The small space left anteriorly and posterior to the sternum is called the *anterior mediastinum;* that posterior and in front of the vertebræ is the *posterior mediastinum.* The space between the two, the *middle mediastinum*, contains the lungs and heart. The anterior mediastinum is wider superiorly and inferiorly than in the centre, and is somewhat X-shaped; the superior portion contains the origin of the sterno-hyoid and thyroid muscles, and the remains of the thymus gland. The posterior mediastinum is longer than the anterior, and includes the œsophagus, the larger blood-vessels, and the thoracic duct.

Pl. 130, *fig.* 3, cross-section of the thorax to exhibit the course of the pleuræ: [1], heart within its pericardium; [2, 3], substance of the lungs; [4], right pleura arising from the ribs and their cartilages; it bends back along the sternum, leaves the anterior mediastinum, [5], between it and the left pleura, passes over the pericardium, embraces the pulmonary vessels, passes over the lung, bends back again posteriorly, [7], the posterior mediastinum being formed between it and the left pleura as before.

1. The Thyroid Body or Gland is a large, soft, red mass, of a crescentic shape, and lying on the trachea and sides of the larynx. It consists of two large pyramidal portions, called *lateral lobes*, connected by a narrow slip, the *middle lobe* or *isthmus*. The thyroid body is surrounded by a fine tissue; it is of a soft spongy texture, the cells containing a yellow fluid. Four

arteries, two from the carotid and two from the subclavian, are distributed to it. Its proper function is not known, although some consider it to belong to the secreting glands, while others with more probability suppose it to be in some way concerned in sanguification. It is very subject to enlargement by disease, constitutiug the affection called *bronchocele* or *goitre.*

2. THE THYMUS BODY is another organ of ambiguous character, and only in its highest state of development in the fœtus before birth. It occupies the greater portion of the anterior mediastinum, and after birth decreases, until by the time an individual arrives at puberty it will have almost entirely disappeared. Some authors suppose its function to consist in the preparation of a fluid, like chyle, and fitted for fœtal growth before birth, and before chyle can be formed from food.

4. The Function of Respiration.

The process of breathing consists of two distinct operations: *inspiration*, by which the external atmospheric air is brought into contact with the blood and yields up oxygen, and *expiration*, in which the carbonic acid formed in the combustion of the oxygen is exhaled together with other gaseous matters. The chemistry of breathing is a consequence of these physical operations.

Inspiration, or the drawing in of the breath, is produced by the expansion of the thorax, by which a partial vacuum being effected, the air rushes into the lungs and inflates them. A subsequent contraction of the parietes of the thorax will cause the expulsion of the air thus introduced. The glottis is connected with the pharynx, from which there are two ways for the air to escape or enter, one through the nostrils, the other through the mouth. It is more usual, however, when not otherwise influenced, to inspire through the former and expire through the latter. At the instant of inspiration, the thorax enlarges in all its dimensions; the diaphragm is depressed or drawn down, the ribs are raised and drawn outwards, this involving a protrusion of the sternum. In expiration all parts return to their former position. The muscles especially concerned in respiration are, the diaphragm, the intercostals, the levatores costarum, the scaleni, the serrati, the sterno-cleido-mastoid, longissimus dorsi, and the subclavius. The abdominal muscles are chiefly employed in expiration, but are assisted by the quadratus lumborum and the triangularis sterni. There are, however, other muscles concerned in respiration, especially such as fix the head. neck, and back, for the better action of the first set. In children, the abdominal muscles are more especially called into requisition, as shown in the rise and fall of the abdomen in breathing. In adult males this rise and fall are seen in the lower part of the thorax, while in women it is the upper part of the chest that heaves.

The entrance and escape of air are accompanied by a peculiar sound, distinctly audible by applying a stethoscope to the chest. The normal sound thus observed varies materially in diseases of the lungs and air

passages, so that this instrument gives invaluable indications as to the extent and nature of pulmonary disease.

Physical and chemical phenomena of respiration. The tension of the gases in the air passages of the lungs varies according to the intensity of respiration. In quiet breathing, this amounts to $\frac{1}{30}$ or $\frac{1}{40}$ of the strength with which the blood usually flows in the larger arteries. In feeble respiration the amount is not more than half of this. These values increase with any obstruction to respiration. The circumference of the thorax at the pit of the stomach in full grown men, amounts during quiet respiration to from $\frac{11}{25}$ to $\frac{1}{2}$, rarely $\frac{11}{20}$ of the length of the body. Each single aspiration continues longer than a contraction of the heart, and its duration increases with age. The new born infant generally respires forty-four times in a minute, the child of five years only twenty-six. From fifteen to twenty years, twenty times; from twenty to twenty-five, eighteen times; from twenty-five to fifty, sixteen or eighteen times. A mean act of respiration, therefore, in the adult lasts from three to four seconds. These values are of course subject to considerable variation.

The air introduced into the lungs is first brought to the temperature of the body, whatever be the temperature of the external atmosphere. Again, the air in the lungs is saturated with moisture, the amount dependent upon the barometric pressure and the temperature. During respiration in a cool atmosphere, the exhaled air must contain more moisture than the atmosphere itself. Consequently the blood loses more moisture in winter than in summer, this difference, however, being equated by the greater loss by perspiration during the latter season; in winter again, the amount of urine discharged is greater. The amount of water lost depends upon the size of the lungs. Adult men between seventeen and thirty-five years may lose from $\frac{1}{2}$ to $\frac{18}{25}$ pounds in twenty-four hours. The number of aspirations does not seem materially to affect the result.

The composition of atmospheric air is pretty much the same in all countries and during each season of the year, the variation observed being exceedingly slight. Recent experiments show that there are 20.81 parts of oxygen and 79.19 of nitrogen by volume, and 22.01 of oxygen and 76.99 of nitrogen by weight. The amount of carbonic acid appears subject to decided variation, although, under ordinary circumstances, it is exceedingly slight. The air over the sea appears to contain less oxygen than that above the land and along the coast; and again, on the other hand, the air contained in snow is richer in this gas. According to some observers, the amount of oxygen in the air of high mountains and deep mines is less than the standard.

A series of carefully conducted analyses of *expired air* shows that the oxygen is in much less proportion than in the atmosphere, while there is a large amount of carbonic acid. This carbonic acid must therefore have been formed in the system by the combination of oxygen with carbon of the blood. The amount of oxygen absorbed is about 23 per cent. The total amount of carbonic acid exhaled by a man within a given time may be expressed either by weight or volume, or by the value of the carbon

contained in it. 275 parts by weight of carbonic acid contain 75 parts of carbon and 200 of oxygen. In one hour 10.572 grammes of oxygen are consumed, that is, 38.764 grammes of carbonic acid are generated. This amount varies greatly, however, with age, sex, and external conditions.

In males the carbonic acid exhaled regularly increases from eight to thirty years of age; from thirty to forty it is stationary; and from fifty to extreme age it goes on diminishing. It is greater in males than in females at all ages beyond eight years. In females, nearly the same proportionate increase goes on to the time of puberty, when the quantity abruptly ceases to increase, and remains stationary as long as menstruation continues, again to increase when this ceases. The more robust the individual, the greater is the amount of carbonic acid given off.

Although the volume of the nitrogen taken into the lungs remains nearly the same, yet there is a constant absorption and exhalation of this gas. The amount is somewhat greater in summer than in winter. There is usually some organic matter contained in exhaled air, either chemically or mechanically, as sulphuric acid is reddened by being breathed through for a considerable time.

The reaction which takes place between the air and the blood is one of simple endosmose and exosmose. If the blood come to the lungs charged with carbonic acid, and is exposed in their cells to the influence of atmospheric air, which is a mixture of oxygen and nitrogen, the carbonic acid will pass out, to be replaced by oxygen and nitrogen. The quantity of oxygen which enters will be much greater than that of nitrogen, owing to the superior facility with which oxygen passes through porous membranes. If the venous blood contain nitrogen as well as carbonic acid, it also will pass out, to be replaced by oxygen. The relative amount of these several interchanges of gases will be subject to continued variation from secondary causes. The combination of oxygen with carbon, to form carbonic acid, takes place not only in the lungs, but throughout the whole system, and this combustion is attended with the evolution of a considerable amount of heat. To this is mainly to be ascribed the *animal heat* of the body, which in man amounts at a mean to about 100° F.

VII. ORGANS OF DIGESTION.

(SPLANCHNOLOGY.)

The daily wear and tear of life, involving the destruction of life in individual atoms of the body, the loss of matter in the secretions and excretions, and the necessity of supplying fuel to keep up the temperature of the body, all require the constant introduction of fresh organic matter to supply the waste. A wise Providence has imparted to us certain sensations, known as hunger and thirst, by means of which we are enabled to ascertain when solid and liquid food is required. The various alimentary substances are taken into the mouth and masticated by the teeth, then carried to the

stomach after having been mixed with the salivary secretion. In the stomach, the food is acted on by the gastric juice, and reduced to a pulpy mass termed chyme. Passing out of the pyloric orifice, the chyme enters the small intestines, and after having been mixed with the juices secreted by the pancreas and liver, becomes converted into chyle, and a residuum. The former is taken up by the lacteals, and ultimately poured into the descending current of venous blood; the latter passes in the form of excrement. Such are the general changes which take place, to be more fully described hereafter.

Such substances are alone adapted for purposes of nutrition as contain water, and a greater or less amount of organic matters capable of mixing with the fluids of the body. Certain nations, indeed, forced by custom or by necessity, devour mineral matters, as the Otomacs and Guamos in Guinea, who eat a clay, the inhabitants of New Caledonia, who mix a certain earth with their food, and the Laplanders, who in time of scarcity consume the bergmehl, tripoli, &c.; but these contain a small amount of organic matter, being composed almost entirely of the shields of infusoria. A long continued use of these substances is, however, exceedingly pernicious. Proper food must contain organic matter in a form capable of being assimilated by the digestive organs, and must include all the elements of the body. For this reason, starch and sugar cannot alone sustain life for a great length of time, owing to the absence of the necessary nitrogen, sulphur, phosphorus, and lime; and some substances even which fulfil these conditions may be incapable of supporting life. Thus, the fibrine of the blood contains most of the necessary elements, yet a dog fed exclusively upon it soon dies. The same applies to the gelatine from boiled cartilage and bones, tendons and ligaments. A well regulated alternation in the character of food consumed is imperatively required by the system. Thus the coagulated white of egg, when mixed with other substances, is exceedingly nutritious, yet animals cannot live upon it exclusively for any great length of time without danger to life. The same principle holds good in respect of the exclusive use of meat or of any other food.

The organs of digestion consist of an uninterrupted alimentary canal extending from the lips to the anus, and of numerous glandular bodies placed along its track, and pouring into it their secretions. This canal is in three portions, a superior, middle, and inferior, constituted by, first, the mouth, pharynx, and œsophagus; second, the stomach and small intestines; and third, the large intestine. The glandular organs are the salivary glands, the pancreas, the liver, and the spleen.

1. Organs of Mastication and Deglutition.

1. The Mouth. The mouth, or cavum ori, is bounded anteriorly by the lips, superiorly by the hard and soft palate, laterally by the cheeks, inferiorly by the tongue and mucous membrane reflected from it to the gums; posteriorly it communicates with the pharynx; this opening is named the

isthmus faucium, is bounded above by the velum and uvula, below by the tongue, on each side by the arches of the palate.

The anterior part of the palate, or *hard palate*, is formed of the palate plates of the maxillary and palate bones, covered by mucous membrane and glands; the posterior part of the palate, or *soft palate*, or *velum pendulum*, consists of a dense aponeurosis, and of several muscles and glands, inclosed in mucous membrane.

The cheeks are formed of mucous membrane, covered by the buccinator and a quantity of fat; several small mucous glands lie between the membrane and this muscle, and towards the upper and back part on each side we perceive the small opening of Steno's duct.

The lips are composed of integuments with more or less of fat, muscles, vessels, nerves, glands, and mucous membrane. The skin is delicate and vascular, particularly at the red borders, where it is continuous with the mucous membrane of the mouth. The cuticle is continued over the latter to line the whole cavity as a very fine epithelium. The muscles are, the orbicularis oris, with which the fibres of many others (already described) intermingle. The arteries of the lips are the coronary vessels, assisted by their inosculations with branches of the internal maxillary artery. The sentient nerves are derived from the infra-orbital and dental branches of the fifth, and the motor from the seventh pair. The labial glands are very numerous; they are rounded and pale, and are situated in the submucous, loose cellular tissue, at some distance from the red border. The mucous membrane is continued from each lip to the alveolar processes of the maxillæ, and forms in the centre of each a small fold or frænum; this is larger in the upper than in the lower lip.

The mouth is lined throughout by mucous membrane, which is continuous with the cutis on the lips, and extends posteriorly through the pharynx, whence it ascends to line the nares, the Eustachian tube, and tympanum, on each side, and descends to line the œsophagus and larynx; it is also continued into the ducts of the sublingual, submaxillary, and parotid glands; as it is reflected from one surface to another, it forms folds or fræna, as between the lips and alveoli and beneath the tongue; at the sides of the fauces, also, it forms two semilunar folds on each side, called the pillars or arches of the palate; these folds inclose muscular fibres, which we shall examine afterwards.

On looking into the mouth, either in the living or dead subject, the following objects strike the attention: inferiorly, the tongue and inferior teeth; laterally, the cheeks; posteriorly, the back part of the pharynx; superiorly, the superior teeth, the hard and soft palate, from the centre of the latter the uvula, and from the sides, the pillars or arches descending to the tongue and pharynx; in the recess between these pillars on each side, the tonsils or amygdala are also seen; lastly, if the tongue be drawn forward, the epiglottis comes into view.

Pl. 129, *fig.* 30, cavity of the mouth: [1], palate; [2], velum palati; [3], uvula; [4], arch of the palate to the mucous membrane of the pharynx; [5], arch to the tongue; [6], tonsil; [7], tongue; [8], epiglottis, and beneath this the pharynx

opened. *Fig.* 31, pharynx opened from behind, showing the posterior part of the fauces: [1], internal pterygoid muscle; [2], stylo-pharyngeal muscle; [3,4], posterior nares; [5], velum palati with the uvula; [6,7], its two crura to the tongue; between them the depression for the tonsils, [8]; [9], isthmus faucium; [10], base of the tongue; [11], opening of the larynx; [12], posterior wall of the larynx; [13], portion of the trachea.

2. THE TONGUE, though somewhat triangular, is of a very variable shape; its base, thick and broad, is connected to the epiglottis and to the palate by folds of mucous membrane (the former are the fræna of the epiglottis, the latter are the arches of the palate), and to the os hyoides and inferior maxilla by muscles, to the latter also by a mucous fold, the frænum linguæ; the apex is thin and unattached; that portion between it and the base is named the body of the tongue; all the upper surface, the sides, and about one third of its inferior surface, are covered by mucous membrane, which is very rough superiorly, from the number of papillæ that project through it; anteriorly, these papillæ are small, conical, and connected with the terminations of the nerves of taste; posteriorly they are large, round, fungiform, lenticular, and very irregular; these are small glands which open on the mucous surface; near the epiglottis these glandular papillæ are often observed to have a peculiar arrangement, like the letter V, the concavity turned forwards; these are of a conical form, the apex attached in a little membranous cup or calyx; behind the apex of this angle a deep depression (foramen cœcum) is observable; this contains some mucous follicles. A superficial groove or raphe runs along the dorsum or top of the tongue; one more distinct exists along the inferior surface; and a cellulo-ligamentous line divides it mesially into two symmetrical portions. This line is more distinct near the base; in some animals it is very dense and even bony; in paralysis one side only of this organ is frequently found affected. The substance of the tongue is composed of adeps blended with numerous muscular fibres derived from the stylo, hyo, genio-hyo-glossi, and lingualis muscles, and of many other fleshy fibres which do not properly belong to any of these; two large arteries (lingual) and six considerable nerves (the gustatory, the lingual and the glosso-pharyngeal, on each side) supply this organ. The tongue is not only the organ of taste, but by its great mobility it assists in speech, in suction, and in deglutition. The fifth pair of nerves endow the tongue with sensation and with the sense of taste, the ninth with mobility, and the eighth supply its base with sensation, and connect the motions of this organ with those of the pharynx and stomach.

Pl. 129, *fig.* 27, dorsum or top of the tongue: [1], foramen cœcum; [2,2], fungiform papillæ of the tongue; [3,3,3,3], conical papillæ; [4,4,4,4], series of filiform papillæ; [5], mucous gland of the base of the tongue; [6,6,6], folds of the mucous membrane to the epiglottis.

Pl. 127, *fig.* 4, hyoid muscles of the right side: [1], anterior; [2], posterior belly of the digastric muscle; [3], mylo-hyoid muscle; [4], stylo-hyoid do.; [5], stylo-glossus muscle; [6], stylo-pharyngeal do.; [7], sterno-hyoid do.; [8], omohyoid muscle; [9], thyro-hyoid muscle; [10], sterno-hyoid muscle. *Fig.* 7, muscles of the tongue: [1], stylo-glossus; [2], hyo-glossus; [3], lingualis; [4], lower

end of the genio-glossus; [5], its anterior, and [6], its posterior fasciculus; [7], median line of the tongue.

3. THE TEETH. The teeth are small, hard bones, thirty-two in number in the adult, sixteen in each jaw; their form is generally conical, the apex in the alveoli. In each tooth we distinguish the crown, neck, and root. The *crown* is external to the alveolus; it has no periosteum, but is covered by a firm, white, vitreous substance, named enamel. The *neck* is surrounded by the gum, and the *root* is firmly held in the alveolus by a mode of connexion called *gomphosis;* it is covered by the periosteum which lines the alveolus, and which is reflected upon it from the point to the neck. The root or fang of each tooth is perforated by a small hole for the nutrient nerve and vessels. The teeth are divided into three classes, the incisores, the canini, and the molares.

The *incisores* are four in each jaw. The crown of these is sharp and wedge-shaped, convex before, and thickly covered with enamel. The neck is constricted, and the root is conical, but flattened on each side. Those in the upper are stronger and larger than those in the lower jaw; the former are broader; their edge is like a chisel, cut off posteriorly; the latter are more vertical, and bevelled off anteriorly; they are not so sharp as those in the upper jaw; their roots are larger. The middle incisors in the upper jaw are much larger than the lateral, but in the lower the lateral are a little larger than the middle.

The *canine teeth*, or *cuspidati*, are two in each jaw, or one on each side of the lateral incisors. The crown is conical, a little blunt, convex before; their root is single, but very long, and larger than those of the incisors, flattened at the side, and grooved. Their alveoli are often very prominent.

The *grinders*, or *molares*, are twenty in number, ten in each jaw. The crown of these is broad and irregular; the roots are more or less divided. The two first molars on each side in each jaw are called *bicuspidati*, and are of an intermediate size between the canine and posterior molars. They have only two tubercles on the crown, which is rather round. The fangs in some are single, but usually double; the lower are smaller than the upper, and the tubercles on the crowns are not so deeply separated. The first lower bicuspid frequently wants the inner tubercle, and resembles a canine. The posterior grinders are the true molars or *multicuspidati*, three on each side in each jaw. These are large; the crown is somewhat square, has four, and sometimes five tubercles; the neck is thick and round; the root has three or four divisions, and each is perforated by a small hole. The crowns of the lower are rather larger than those of the upper; the latter are vertical, but the former are inclined a little inwards. The fangs of the lower are usually two, but very broad and strong, placed anteriorly and posteriorly, often much curved, flattened before and behind, grooved and often bifid. The first and second upper have usually three roots, one internal, two external; sometimes they have four. The first molar is generally the largest; the last, or dens sapientiæ, is the smallest; its crown is short, and has only three tubercles, two external and one internal. The root, though often single, is grooved, and sometimes presents three partial

divisions in the upper and two in the lower. These last teeth, however, are very variable as to size and other characters, and occasionlly are not protruded, particularly in the upper jaw.

Every tooth, when divided, presents an external shell or cortex, and an internal cavity which extends beneath the crown, partly corresponding to it in form, and contracts as it descends through the root into a fine tube, which ends in a minute foramen. In the young and growing tooth this cavity is large, and contains a soft, vascular pulp or bulb; in the course of time it is much diminished by surrounding osseous or ivory deposit, and in the adult or aged contains little more than a vascular lining membrane. The walls of this cavity, though very firm, are perforated by numerous minute pores, which lead into the solid texture of the tooth. The substance of a tooth consists of three elements: enamel, ivory or dentine, and crusta petrosa or cement. The enamel covers the crown; the ivory forms the greater portion of the body and root; and the crusta, in the form of a thin lamina, invests the root only, though, according to some, it is also prolonged over the crown and enamel.

The teeth make their appearance at a very early age of the fœtus, although requiring a long time for their full development; it is not till the sixth or seventh month after birth that the two middle incisors of the lower jaw come out. The remaining incisors follow at intervals of from four to six weeks; first the two median upper ones; then the two exterior lower, and lastly the two exterior upper. The uppe. and lower anterior molars of each side of the jaw next make their appearance, followed by the canines, and finally by the posterior molars. At the end of the second year the child has twenty teeth. These are called milk teeth, from making their appearance during the period of suckling. The incisive and canine milk teeth are smaller than the permanent; the posterior molars on the other hand are larger. About the seventh year the milk teeth fall out and are replaced by the permanent, in nearly the same order as that of their first appearance. After all the incisors are changed, the anterior and posterior temporary molars are successively shed, and replaced by the permanent bicuspids; the canines are not changed before the tenth or eleventh year. After the twelfth or thirteenth the second permanent molars appear, and the last or dentes sapientiæ (wisdom teeth) seldom before eighteen or twenty, and occasionally at a much later period.

Pl. 123, *fig.* 18, the teeth of both jaws from before. *Fig.* 19, do. from the side. *Fig.* 20, the lower jaw of a child four years old with the milk teeth and their sockets. *Fig.* 21, the same for the upper jaw. *Figs.* 22 and 23, upper and lower jaw opened, with the milk and permanent teeth in their sockets or alveoli. *Fig.* 24, dental sac of a milk tooth with its vessels. *Fig.* 25, do. of a permanent tooth. *Fig.* 26, vertical section of the tooth cavity contained by the sac. *Fig.* 27 *a–e*, the teeth of the right upper jaw of a fœtus of about eight months. *Fig.* 28 *a–e*, teeth of a newborn child. *Eig.* 29 *a–e*, teeth of a child of four years. *Fig.* 30, second set of upper jaw teeth of a four years' old child seen from within. *Fig.* 31, do. from below. *Fig.* 32, teeth of a child at seven years: A, milk teeth; B, per-

manent teeth. *Fig.* 33, teeth of a grown man. *Fig.* 34, the posterior molar or wisdom teeth.

4. THE PALATE. The palate is composed anteriorly of the palatine processes of the superior maxillary and palatine bones, covered above by the mucous membrane of the nose, and below by the lining membrane of the mouth. This portion is the hard palate, and separates the mouth from the nose. Behind it is a membranous portion called the soft palate, which partially separates the mouth from the upper part of the pharynx. The portion of the lining membrane of the mouth which covers the hard palate has a hard cartilaginous feeling, and is not so sensitive as the other parts. It has a ridge in its centre just below the middle palatine suture, and from each side there are transverse ridges extending to the alveolar processes. This arrangement is more evident anteriorly. Beneath this membrane, especially at its posterior part, the muciparous glands are very abundant and close set.

The soft palate, *velum palati*, is continuous with the posterior margin of the hard palate, and is stretched across the back part of the mouth from one side to the other and obliquely downwards and backwards. Its free inferior margin offers in its centre a projection about half an inch or more in length, and called the *uvula*. From each side of the latter there proceed two crescentic doublings of the lining membrane of the mouth called the lateral half arches of the palate. Of these the anterior is the more distinct. The tonsils are contained in the depression between these two duplicatures.

The *muscles of the palate* are, first, the *constrictor isthmi faucium*, arising from the middle of the soft palate, and inserted into the side of the tongue near its root. It tends to close the opening between the mouth and the pharynx. Second, the *palato-pharyngeus*, a small fasciculus within the duplicature forming the posterior lateral half arch. Extending between the soft palate and the pharynx, it serves to draw the former downwards. Third, the *circumflexus* or *tensor palati* behind the pterygoid process of the sphenoid bone. It spreads out or extends the palate. Fourth, the *levator palati* on the inner side of the last. It arises from the point of the petrous bone, and attached to the soft palate, draws it upwards. Fifth, the *azygos uvulæ*, in the centre of the soft palate and of the uvula. It arises from the posterior pointed termination of the middle palatine suture, and serves to draw the uvula upwards, and to diminish the vertical breadth of the soft palate.

Pl. 127, *fig.* 5, muscles of the palate and posterior side of the pharynx: [1], levator palati; [2], tensor palati; [3,3'], azygos uvulæ; [4], glosso-palatine muscle; [5], constrictor isthmi; [6], posterior crico-arytenoid muscle; [7], transverse and oblique arytenoid muscles. *Fig.* 6, palatine muscles: [1], external pterygoid; [2], levator palati; [3,4], tensor palati; [5], azygos uvulæ; [6], upper end of the constrictor isthmi.

5. GLANDS OF THE MOUTH. The principal glands of the mouth are for the purpose of secreting saliva, a substance essential to the proper mastication, deglutition, and digestion of food. They consist of the parotid, the submaxillary, and the sublingual.

The *parotid gland* is the largest, and, like the rest, of a pink color. It fills up the cavity on the side of the head between the mastoid process and the ramus of the lower jaw, extending beyond the edge of the latter, so as to cover the posterior margin of the masseter muscle. It reaches vertically downwards from the zygoma above to the angle of the jaw below. It has no appropriate capsule, but is covered by the processes from the superficial fascia of the neck. Its duct, called the *duct of Steno*, traverses the outer face of the masseter muscle, in a line drawn from the lobe of the ear to the tip of the nose. It is about the size of a crow-quill, and perforates the posterior part of the buccinator muscle so as to have its oral orifice opposite the second large molar tooth of the upper jaw. A small accessory gland is sometimes found between this duct and the zygoma.

The *submaxillary gland* is about one third the size of the parotid, and is so situated as to be bounded externally by the body of the lower jaw, superiorly by the mylo-hyoid muscle, and inferiorly by the tendon of the digastric. Its duct (*ductus Whartonianus*) terminates by a small projecting orifice on the anterior margin of the frænum of the tongue.

The *sublingual gland* is an oblong body, visible on turning up the tongue, where it is seen as a projecting ridged substance on the under surface of the tongue. Instead of a single excretory duct, it has several, sometimes twenty. Occasionally, several of them are collected into one or two principal trunks (*ductus Riviniani*), which open either directly into the mouth or into the duct of Wharton. The position of the salivary glands is such that they are pressed upon during mastication, by which means their salivary secretion is expressed. All consist of a congeries of smaller glands or lobes and lobules. The arteries which supply them are branches from the external carotid. Their nerves come from the fifth pair, and from the portio dura.

The *tonsils*, or *amygdalæ*, situated one on each side, between the half arches of the palate, constitute a series of mucous glands of irregular figure. They are very vascular, and secrete a viscid fluid, which serves to lubricate the food in its downward passage.

Pl. 129, *fig.* 29, salivary glands: [1], sterno-cleido-mastoid; [2], masseter muscle; [3], parotid gland; [4], accessory parotid; [5], single glandules distributed about its duct near the end; [6], genio-glossus; [7], mylo-hyoid; [8], external, [9], internal portion of the submaxillary gland; [10], ductus Whartoni; [11], upper maxillary ganglion; [12], sublingual gland.

6. The Pharynx is a large membranous cavity, placed between the cervical vertebræ and the posterior part of the nose and mouth. By means of numerous attachments on all sides, it is prevented from collapsing, and it is drawn up and down in the movements of the tongue and larynx. It consists of three coats, an external, formed by three muscles, the *constrictores pharyngis*, *inferior*, *medius*, and *superior;* an intermediate pharyngeal aponeurosis; and the internal or lining mucous membrane. This mucous membrane is continuous with that of the mouth, nares, and Eustachian tube, and is continued inferiorly as a lining to the larynx and trachea in front and to the œsophagus behind. It is studded with numerous mucous glands.

On opening the pharynx from behind, we may observe seven apertures leading from it in different directions: in the upper or nasal portions there are the two posterior nares, and on the side of each of these there is the opening of the Eustachian tube; below the velum palati there is the isthmus faucium or posterior opening of the mouth; below and behind the tongue is the opening of the glottis; and, lastly, we have the termination of the pharynx in the œsophagus.

7. THE ŒSOPHAGUS is the tube in front of the spine, and behind the trachea, which conducts food from the pharynx to the stomach. When inflated, it is of cylindrical shape, about an inch in diameter, and nine or ten inches long, widening towards the stomach. Like the pharynx, it consists of three coats, an external or muscular, a middle or aponeurotic, and an internal or mucous.

8. PHYSIOLOGY OF MASTICATION AND DEGLUTITION. The first step in the reduction of food taken into the mouth is its mastication, and the addition of salivary matter to the divided particles. Mastication evidently is of great importance in preparing the substances to be afterwards operated on for the action of their solvent; and it exactly corresponds with the trituration to which the chemist would submit any solid matter, that he might present it in the most advantageous form to a digestive menstruum. The complete disintegration of the alimentary matter, therefore, is of great consequence; and, if imperfectly effected, the subsequent processes are liable to derangement. This derangement we continually meet with; for there is not, perhaps, a more frequent source of dyspepsia (difficult digestion) than imperfect mastication, whether resulting from the haste with which food is swallowed, or from the want of the proper instruments. The disintegration of the food, by mechanical reduction, is manifestly aided by insalivation; it is doubtful, however, to what degree the saliva has any chemical effect upon it.

When the reduction of the food in the mouth has been sufficiently accomplished, it is carried into the œsophagus by the action of deglutition. The *first* stage in the process is the carrying back of the food until it has passed the anterior palatine arch; this, which is effected by the approximation of the tongue and palate, is a purely voluntary movement. In the *second* stage the tongue is carried still further backwards, and the larynx is drawn forwards under its root, so that the epiglottis is pressed down over the rima glottidis. The muscles of the anterior palatine arch contract after the morsel has passed it, and assist its passage backwards; these, with the tongue, cut off completely the communication between the fauces and the mouth. At the same time, the muscles of the posterior palatine arch contract in such a manner as to cause the sides of the arch to approach each other like a pair of curtains, so that the passage from the fauces into the posterior nares is nearly closed by them; to the cleft between the approximated sides the uvula is applied like a valve. A sort of inclined plane, directed obliquely downwards and backwards, is thus formed, and the morsel slides along it into the pharynx, which is brought up to receive it. Some of these acts may be performed voluntarily, but the combination of the whole is instinctive. The *third* stage of the process, the propulsion of the

food down the œsophagus, then commences. This is accomplished in the upper part, by means of the constrictors of the pharynx; and in the lower, by the muscular coat of the œsophagus itself. When the morsels are small, and are mixed with much fluid, the undulating movements from above downwards succeed each other very rapidly; this may be well observed in horses whilst drinking; large morsels, however, are frequently some time in making their way down. Each portion of food and drink is included in the contractile walls, which are closely applied to it during the whole of its transit. The gurgling sound which is observed when drink is poured down the throat of a person *in articulo mortis* is due to the want of this contraction. The whole of the third stage is completely involuntary. The usual peristaltic movements of the œsophagus are reversed in vomiting; and this reversion has been observed even after the separation of the stomach from the œsophagus, as a consequence of the injection of tartarized antimony into the veins. At the point where the œsophagus enters the stomach, the cardiac orifice of the latter, there is a sort of sphincter, which is usually closed. This opens when there is a sufficient pressure on it, made by accumulated food; and afterwards closes, so as to retain the food in the stomach. The opening of the cardia is one of the first acts which take place in vomiting. When the sphincter is paralyzed by the division of the pneumogastric nerve, the food regurgitates into the œsophagus.

2. Organs of Assimilation.

The organs concerned in digesting the food, after it has been masticated and swallowed, are the stomach and intestines, assisted by various glands.

We shall precede the detailed description of the viscera of the abdomen, by a brief reference to its regions, as established by authors. The abdomen is the largest cavity in the body; it is of an oval form; its capacity, and in some degree its figure, differ at different ages, and in different subjects; it is bounded superiorly by the diaphragm, anteriorly and laterally by the abdominal muscles, inferiorly by the true and false pelvis, and posteriorly by the lumbar vertebræ, the crura of the diaphragm, and the psoæ and the quadrati lumborum muscles. Although the expression "cavity of the abdomen" is in common use, it is not correct; for during life there is no cavity, as the diaphragm and abdominal muscles, by their alternate action, keep up such a constant and uniform pressure on the viscera, that these and the parietes are always in perfect contact. The abdomen contains the peritonæum and the organs of digestion; the kidneys, renal capsules, and ureters; also the lacteals or absorbent vessels, with their glands, and the thoracic duct, the sympathetic nerves, the aorta, vena cava, and the numerous branches of these vessels. The abdomen is generally divided by writers into nine, but by some into twelve regions; by drawing two transverse lines, one between the extremities of the cartilages of the ninth or tenth ribs, and the other between the anterior superior spinous processes of the ossa ilii, we may define three regions: the *epigastric* above, the *umbilical* in the middle, and

the *hypogastric* below; and then, by drawing a vertical line on each side, from the extremity of the eighth or ninth rib to the centre of Poupart's ligament, or a little external to it, we shall subdivide each of these regions into three parts: the three divisions of the epigastric region are the *epigastrium*, or scrobiculus cordis, in the centre, and the *right* and *left hypochondriac regions*, on either side. The epigastrium is immediately below the ensiform cartilage, and the hypochondriac regions are covered by the false ribs; the lateral portions of the *umbilical* division are the *lumbar regions;* the middle of the hypogastric region is the *hypogastrium;* and the lateral portions are the *iliac regions.* The lower part of the hypogastrium is called by some the *pubic region*, and the lower part of each iliac division is called *inguinal region*, or more properly *spermatic* (the term inguinal being commonly applied to the upper and anterior part of the thigh), and contains the iliac vessels, and in the male the spermatic cord, and in the female the round ligament of the uterus. These divisions are somewhat arbitrary, there being no natural or fixed boundaries to these several compartments.

1. The Stomach. The stomach is the most dilated portion of the alimentary canal, its capacity, however, being very variable. It is placed between the œsophagus and the duodenum, continuous with both, and is held in its place in the abdomen by the omentum and œsophagus. When distended, the stomach exhibits a somewhat conical figure, the base to the left side, the apex to the right, the intermediate portions being somewhat curved. It then presents two extremities, the left and the right; two orifices, the cardiac and pyloric; two surfaces, an anterior and a posterior; and two edges, the lesser or concave, and the greater or convex. The *left*, or *splenic extremity*, is very large; the *right*, or *pyloric*, is much smaller, being cylindrical and convoluted like an intestine, and is distinguished from the duodenum by the circular contraction of the pylorus, to the left of which the stomach is often found dilated towards the convex border, into a little sinus called *antrum pylori.* The *cardiac œsophageal orifice* is the highest point of the stomach, and is connected to the diaphragm by the peritonæum. The *pyloric orifice* is between the stomach and the duodenum. It lies to the right side of the spine, and is usually in contact with the liver and gall bladder. The *anterior surface* of the stomach is below the xiphoid cartilage, looking upwards and forwards. The *posterior surface* looks backwards and downwards, forming the front of the bag of the omentum. The *lesser*, or *concave edge*, looks backwards and upwards towards the spine. The *greater*, or *convex edge*, looks forwards and downwards towards the colon.

The stomach is composed of three proper tissues: a serous, a muscular, and a mucous. These are connected together by laminæ of cellular membrane. The *serous* or *peritonæal coat* is derived from the lamina of the lesser omentum, separating at the lesser curvature, and uniting along the convex edge to form the great omentum. It does not adhere throughout, but leaves spaces, allowing the distension of the stomach and the passage of blood-vessels. The *muscular coat* consists of three layers; the first, or superficial, is longitudinal, continued from the longitudinal fibres of the œsopha-

gus, and extending towards the duodenum. The second layer consists of fibres running circularly in nearly parallel rings, beginning at the left extremity. The third set of fibres take a very irregular or oblique direction, and appear as a continuation of the circular fibres of the œsophagus. The *internal* or *mucous coat*, also called villous, from its velvety appearance, is continuous with that lining, the œsophagus, and duodenum. When fresh and healthy, it is of a rosy or pinkish color. It is always thrown into folds or wrinkles, some of which are nearly parallel to the long axis of the stomach, and thus permit the distension of this organ; other folds intersect these, so as to cause an areolated appearance. At the cardiac orifice this membrane is folded longitudinally, and somewhat festooned. Corresponding to the pylorus is a circular fold, with a small aperture in the centre, the *pyloric valve*, encircled by a strong band of sphincter fibres; during life, when the sphincter acts, it can effectually separate the stomach from the intestine. When the stomach and duodenum are inflated and dried, the valve will be seen to present an appearance not unlike that of the iris. On carefully cleaning the inside of the stomach from all mucus, it will exhibit numerous projecting papillæ, and between them small pits or depressions, studded with minute holes. These pits are more or less circular, and most distinct towards the pyloric orifice; they secrete the gastric juice, the mucus being probably furnished by the papillæ.

The stomach is freely supplied with blood from the cœliac axis; the coronary and epiploic arteries, with the vasa brevia, inclose it in a network of inosculation. The numerous large veins enter into the portal system. The eighth nerves expand on its surface, and form a plexus round the cardiac orifice. Numerous nerves also are derived from the solar plexus of the sympathetic.

The mucous coat of the stomach secretes the peculiar anti-putrescent and powerfully solvent liquid known as the *gastric juice*. By its action, aided by the temperature of the body and the motion of the stomach, food introduced through the œsophagus is, after a time, converted into a grey pulpy mass termed chyme. It is probable that the saliva (mixed with which the food comes to the stomach) performs an important part in the operation of digestion.

2. THE DUODENUM is the next portion of the alimentary canal. It is so named from its length (from eight to nine inches), being about equal to the breadth of twelve fingers. This is the first and shortest, but most dilatable division of the small intestine; it extends from the pylorus to the root of the mesentery, where the jejunum commences. The *superior transverse portion* ascends from the pylorus backwards and to the right, where it makes a sudden or acute turn, and the *middle* or *perpendicular portion* then descends in front of the right kidney as low as the third lumbar vertebra; here it makes a second turn, from which the *inferior transverse portion* extends obliquely across the spine. The biliary and pancreatic ducts perforate the inner side of the perpendicular division of the duodenum. These pass through its coats very obliquely, and open into the intestine, sometimes separately, sometimes together, on a small papilla opposite the inferior angle. In the

duodenum, the process of digestion is completed; the chyme is mixed with the biliary and pancreatic juices, and a separation takes place between the chyle and the excrementitious matter.

3. The Jejunum and Ileum Intestines are partly concealed by the omentum. There is no exact division between these two portions, the upper two fifths being named jejunum, and placed higher in the abdomen than the remaining ileum. From the duodenum the jejunum first passes forwards and to the left side; it then descends into the middle of the abdomen, is folded upon itself over and over again, extending into various regions; finally, the terminating portion of the ileum rises out of the pelvis from left to right, and joins the cœcum at an acute angle convex upwards. This portion of the intestinal tract is well supported by the mesentery, so that while possessing sufficient freedom of motion, and the power of accommodating itself to the various displacements produced by muscular action, it is securely tied in its place.

The large intestine, from four to five feet long, is divided into cœcum, colon, and rectum. It differs from the small, not only in size but in being cellular or sacculated when distended; small processes too, *appendices epiploicæ*, are attached to it. Three strong longitudinal muscular bands may be observed, puckering it and causing the cellular appearance.

The *cœcum*, or *caput coli*, is a cul de sac in the right iliac fossa, which it nearly fills. It joins the colon at an obtuse angle, although there is no exact limit between them. On its external surface there are three irregular protuberances, one anteriorly and the other posteriorly. The *appendix vermiformis* proceeds from the left side of the lower and posterior part; this is a small tortuous cul de sac about the size of a goose quill, and may be considered as representing the more highly developed cœcum of other animals. The ileum joins the left or inner side of the cœcum at an acute angle, its mucous coat protruding into the cavity of the cœcum to form two valves. The inferior or *ilio-cœcal valve* is the larger; it secures the ileum against regurgitation from the cœcum; the superior or *ilio-colic valve* is smaller, and prevents regurgitation from the colon. These two valves are united at their *commissures* or extremities, and from each commissure a fold is continued round on the inner side of the cœcum; these folds are the *fræna* or *retinacula* of the valves.

4. The Colon extends from the cœcum to the rectum; it is divided into four portions. The *right* or *ascending colon* extends from the cœcum to the inferior surface of the right lobe of the liver. The *transverse arch* of the colon turns off at a right angle from the *last*, and extends tortuously from the gall bladder, transversely as far as the spleen in the left hypochondrium. The *left* or *descending colon* extends from the spleen to the iliac region behind the small intestines, and the *sigmoid flexure* or the fourth division completes the colon to the rectum.

5. The Rectum, or straight intestine, extends from the sigmoid flexure of the colon to the anus. It is more cylindrical and less sacculated than the colon; it is usually found much dilated about an inch above the anus.

The mucous coat of the small intestines, although continuous with that

of the stomach, yet presents some peculiarities, the most important of which is seen in the series of permanent folds or duplicatures named *valvulæ conniventes.* These commence in the vertical portion of the duodenum, and increasing exist in great quantities as far as the upper half of the ileum; they then decrease in numbers and size, and are wholly absent in the last few feet of the ileum. They are semilunar folds or arches extending round one half or more of the tube, into which they project when this is distended, like shelves. They increase the extent of surface of intestine, and delay the food in its downward passage, affording to the absorbents a better opportunity to take up the chyle. The whole mucous surface of the small intestines is furnished with follicles and mucous glands; it also presents numerous projecting processes called villi. The *follicles of Lieberkuhn* are simple pouches of the membrane, very small, and scattered numerously over the whole surface. The more elaborate glands present different appearances. The *glands of Brunner* are chiefly in the duodenum, in the submucous tissue, and surround the intestine in a lamina of white bodies. The *glands of Peyer* are found chiefly along the convex part of the intestine, sometimes single, sometimes aggregated. The function of these glands is unknown. The *villi* are those short cylindrical or conical processes seen so abundantly on the mucous membrane of the small intestine; when examined under a lens they are found to be covered by a fine membrane in addition to the epithelium, and to contain a minute plexus of blood-vessels through the medium of which the absorption of fluids for the canal takes place. The lacteal vessels commence in each villus by small branches, but they do not open on the surface by free orifices as was at one time supposed. At the extremity of each villus are seen small vesicles during the presence of food in the intestines, disappearing when this is empty. These in all probability are developed from nuclei by absorption of matter from the descending food, and soon burst, discharging their contents inwards towards the lacteals. Free fluids are probably taken up directly by endosmosis through the veins distributed along the intestinal tract.

The mucous membrane of the large intestine differs in having no villi and no true valvulæ conniventes. Internally are seen several crests or semilunar folds; these, however, are formed by all the coats, and not by the mucous membrane alone as in the small intestine.

As the food is propelled onwards through the intestines, both large and small, it becomes mingled with a vast quantity of fluid (*succus intestinalis*), secreted by the mucous glands and follicles. In the jejunum and ileum the chyle is absorbed by their numerous villi; the length and tortuosity of the tube, and its numerous valvulæ conniventes, are admirably adapted to increase the extent of this secreting and absorbing surface, and at the same time to retard the progress of the food, and to penetrate and subdivide the mass, so as to search out, as it were, and extract all the nutriment or chyle it may contain. In the large intestine the contents acquire their feculent properties, the first traces of which they exhibit in the cœcum. In their passage along this part of the canal, the absorbents may probably continue

to take up any chyle that may have escaped those in the ileum, as also the watery parts of the food, and the fæces become hardened by degrees, and moulded or figured according to the length of time they are lodged in the cells of the colon. The great length of this tube, as well as its yielding structure, adapt it as a reservoir capable of retaining a considerable quantity, and thus obviating the inconvenience of frequent defecation. The rectum also contributes to the same effect, being retained in a closed state by the sphincters and supported by the levatores ani muscles. When the evacuation of the bowels is called for by the peculiar sensations in the part, the contents are expelled partly by the muscular action of the rectum and the concurring relaxation of its sphincter, aided by the voluntary contraction of the diaphragm and abdominal muscles.

Pl. 130, *fig.* 11, stomach with its fleshy fibres: [1, 2], longitudinal fibres from the cardiac orifice; [3], circular and transverse fibres. *Fig.* 12, œsophagus at its entrance into the stomach: [1], mucous membrane of the œsophagus; [2], do. of the stomach; [3], line of separation between the two; the inequalities indicate the cardiac orifice. *Fig.* 13, valve of the pylorus. *Fig.* 14, intestinal tract: [1], coils of the small intestines; [2], cœcum with its vermicular appendage; [3], ascending, [4], transverse, [5], descending colon; [6], sigmoid flexure; [7], rectum; [8], appendices epiploicæ, folds of the peritonæum filled with fat. *Fig.* 15, portion of the small intestines opened to show the valvulæ conniventes. *Fig.* 16, cœcum opened: [1], end of the ileum; [2], vermicular appendage; [3], its opening into the cœcum; [4], opening of the ileum; [5, 6], folds of the mucous membranes, forming the lips of the valves.

The glandular viscera of the abdomen which are subservient to digestion and assimilation are, the liver, spleen, and pancreas.

6. THE LIVER is the largest and heaviest secreting gland in the body; it is situated below the diaphragm, and above the right kidney, the stomach, duodenum, and lesser omentum; and is supported in this position by several folds of the peritonæum, inaccurately termed ligaments, viz. the falciform, round, right, left, and coronary. These connect it to the diaphragm and to the abdominal muscles, and the lesser omentum attaches it to the stomach and omentum. Its weight varies from three to five pounds, depending on the amount of blood included; its transverse diameter is about ten or twelve inches, the vertical about seven in the deepest part of the right lobe.

The liver is of very irregular form. The superior or anterior surface is smooth and convex, and divided by the suspensory ligament into a right and left portion. The inferior surface looks backwards and downwards; it is very irregular, and marked by several projections and depressions. The former are called *lobes*, and are five in number: first, the *great* or *right lobe;* secondly, the *left lobe*, which rests on the stomach; third, the *spigelian* or *middle lobe*, situated behind the lesser omentum; fourth, the *lobulus caudatus*, immediately behind the transverse fissure; fifth, the *lobulus quadratus* or *anonymus*, at the anterior part of the right lobe.

The principal depressions or fissures on the inferior surface of the liver are: the *transverse fissure* or *porta*, situated between the lobulus quadratus and caudatus; the *horizontal fissure*, extending from the notch in the

anterior edge of the liver upwards between the right and left lobes; the *fissure for the vena cava*, between the lobulus spigelii and the right lobe; the *depression of the gall bladder*, to the right of the lobulus quadratus; two *superficial depressions* on the under side of the right lobe; a *superficial depression* on the under surface of the left lobe; and lastly, a broad notch in the posterior edge of the liver. Several notches may be observed in the circumference of the liver.

The liver is of a peculiar brown color, mottled with yellow, and consists of numerous small granulations or lobules, connected together by branches of the hepatic arteries and veins, and of the vena porta and biliary ducts, and by lymphatics and nerves, the whole cemented together by a fibrous coat which covers the surface, and sends inwards numerous subdividing laminæ so as to form a capsule for each lobule. This coat also accompanies the three vessels of the liver which enter or leave the transverse fissure, and forms a sheath round their ramifications throughout the entire organ, known as *Glisson's capsule.* The lobules are small granules, composed of a plexus of biliary ducts, of a portal venous plexus, of an interlobular branch of an hepatic vein, and of minute arteries. The circulation of blood in the liver has already been described under the vascular system. The venous blood from the vena porta is brought to this organ and distributed throughout its substance. There it is subjected to certain influences which result in the elaboration of bile, which, after collecting from innumerable fine canals, flows into the hepatic ducts which unite into a common hepatic duct. This duct descends for about an inch and a half along the lesser omentum, and is then joined at an acute angle by the cystic duct from the gall bladder; the union of the two forms the *ductus choledochus communis.* The latter duct, about three and a half inches long, perforates the coats of the duodenum very obliquely opposite to its lower angle; here it is usually joined on the left side by the duct from the pancreas.

The *gall bladder* is a pear-shaped reservoir, the neck of which is extended into the *cystic duct*, which joins the hepatic duct at an acute angle to form the choledochus communis. It serves to retain the bile when not wanted in the intestinal canal; when pressed upon by the presence of food in the duodenum, its contents are forced out through the cystic duct and the ductus communis. Bile may pass directly from the liver to the intestines without entering the gall bladder at all.

7. THE SPLEEN is a soft spongy mass, situated between the stomach and ribs, beneath the diaphragm, and above the kidney and colon. It has no excretory duct, but its vein joins the vena porta directly, and it may therefore be considered as accessory to the liver in its function of depuration. Its precise office, however, is not known. On the concave surface, turned towards the stomach, there is a central depression or fissure, termed the hilum.

8. THE PANCREAS, or sweetbread, lies behind the stomach. It is a conglomerate gland, very similar in appearance and texture to the salivary glands. It is flat, thin, and elongated, about seven inches long and an inch and a half broad. The middle portion is called the body; the splenic or left extremity is the *tail;* the right, broad and flat, is the *head.* The *pan-*

creatic duct commences at the small end, and extends to the large, receiving numerous branches on each side. It generally joins the ductus choledochus in a small dilatation just before the duodenal opening; a second duct sometimes opens directly into the duodenum. An accessory gland, called the *lesser pancreas*, is sometimes found attached to the head of the pancreas. The pancreatic juice is mixed with the biliary in the duodenum, to separate chyle from the chyme of the food. Its especial office, from recent investigations, appears to lie in the assimilation of fats.

9. The Peritonæum. The peritonæum is the largest serous membrane in the body, investing the viscera of the abdomen, much as those of the thorax are embraced by the pleura. The peritonæum is a closed sac, and when opened, presents a continuous surface, which may be traced throughout the whole extent without interruption. The different folds which the peritonæum forms in its course are mainly the lesser omentum, the great omentum, the splenic omentum, the colic omentum, the appendices epiploicæ, the mesentery, meso-cœcum, and meso-rectum. The relations of the peritonæum in the different parts of its course will be best understood by reference to *pl.* 130, *fig.* 9.

Proceeding from the umbilicus, [1], the peritonæum passes along the inside of the anterior abdominal wall, [2]; then bending backwards, it lines the inferior surface of the diaphragm, [3], forming on it the suspensory ligament, [4], of the liver, [5]; it passes below the diaphragm over the liver, and coats its upper surface, [6], the gall bladder, [7], and a portion of the lower surface of the liver. From the liver it passes to the stomach, and forms, [8], the anterior lamina of the lesser or gastro-hepatic omentum, and passes from the stomach to the spleen as the anterior lamina of the gastro-splenic ligament. The peritonæum next bends back on itself from the diaphragm in the form of a sac (*saccus epiploicus*), the opening, [10], to which is known as the foramen of Winslow. The two laminæ of the gastro-hepatic omentum separate at the lesser arch of the stomach, [11], to inclose this organ, the posterior layer giving a serous covering to its back part, and the anterior to its fore part; they then touch each other again, [12], along the great arch of the stomach, and being joined by the peritonæum from the spleen and the splenic vessels, descend to the lower part of the abdomen under the name of the gastro-colic or the great omentum, [13]. This then turns on itself and ascends obliquely backwards to the arch of the colon, along the convex edge of which its laminæ separate to inclose this intestine, [14], and its vessels. Along the concave edge of the colon these laminæ again unite, [15], to form the transverse meso-colon which passes backwards to the spine. Opposite the duodenum, [16], this process separates into an ascending and descending layer, between which the inferior division of the duodenum lies. The ascending layer covers the pancreas, [17], and proceeding to the back part of the right lobe of the liver, becomes continuous with the peritonæal layer, [18], of this viscus. The descending layer, [19], of the transverse meso-colon expands in each lumbar region, in which it attaches the lumbar portion of the colon by a duplicature called the right and left lumbar meso-colon; it is thence reflected forwards over the small intestines, [20, 20], and

returns again to the spine, forming the remarkable plaited process, the mesentery, [21, 21]. Inferiorly it covers the sigmoid flexure, [22], and a portion of the rectum, [23], forms duplicate folds, [24], between the rectum and uterus, covers the uterus itself, [25], and constitutes on each side the broad ligament, [26, 26], subdivided anteriorly into three smaller folds, containing the round ligament, the Fallopian tube, and the ovary. It next passes to the posterior surface of the bladder, [27], forms here a few folds, [28], returns to the umbilicus, covers the umbilical vessels, [29], and contributes, [30], to the formation of the lateral ligaments of the bladder. *Fig.* 10, anterior view of the stomach, duodenum, and omentum majus; the posterior portion of the reflected liver is shown: [1], stomach; [2], lower border of the stomach; [3], pyloric extremity; [4], cardiac do.; [5], pylorus; [6], duodenum; [7], head of the pancreas; [8 9], portion of the large intestines; [10], portion of the omentum majus; [11], lower surface of the right lobe of the liver; [12], inferior vena cava; [13], left longitudinal fissure, with the obliterated umbilical vein; [14], transverse furrow or porta, with the vessels; [15], gall bladder and cystic duct, uniting with the hepatic duct into the ductus choledochus communis; [17], trunk of the portal vein; [18], hepatic artery; [19], lobulus quadratus; [20], spigelian lobe; [21], left lobe of the liver. *Fig.* 17, spleen: [1 2], furrow on the convex side; [3, 4], opening for vessels in the concave side. *Fig.* 18, biliary duct, gall bladder, and pancreas: [1], duodenum; [2], gall bladder opened; [3], the small spiral folds of the neck; [4], cystic duct; [5], hepatic duct; [6], common duct; [7], pancreas; [8], right extremity; [9], pancreatic duct.

VIII. URINARY ORGANS.

As many substances are introduced into the system which are either unnecessary or injurious, some means must be devised to remove them from the blood, into which they have been carried, as well as to separate effete particles from the system itself. The skin and the lungs perform much of this office, but the greater share is to be attributed to the urinary apparatus. This consists of the two kidneys which secrete the urine; the two excretory ducts, the ureters, which convey the urine to the urinary bladder, a temporary reservoir; finally, the urethra, which discharges it externally, and which in the male is common to both the urinary and the genital organs.

1. The Kidneys present the well known shape of the kidney bean, and are about four inches in length, two in breadth, and one in thickness. The external surface is smooth, and invested by a capsule, which is attached so loosely as to permit of being readily peeled off. A deep notch on the concave edge of the kidney serves for the passage of its vessels, and marks the *hilum*. The superior end of each kidney is surmounted by the suprarenal body.

A vertical section of a kidney from the convex edge to the concave, will show it to consist of two entirely different substances, an external or vascular and an internal or membranous. The external vascular or cortical

substance forms the superficial lamina of the gland, is about two lines thick, and sends long prolongations inwards between the membranous fasciculi. A microscopical examination shows the cortex to be composed of numerous arterial and venous ramifications, entangled with convoluted uriniferous tubes (tubes of Ferrein); an immense number of small granules may also be detected. These are the *corpora* or *acini of Malpighi.* A Malpighian corpus or corpuscle is a tuft of capillary arteries, arranged in loops, close pressed together, and inclosed in a slight dilatation of the urinary tube, which thus forms a capsule to it. A small artery called *vas inferens* pierces this capsule, and then divides into the branches which are coiled up to form this minute vascular ball, from the interior of which a small vein (*vas efferens*) proceeds, smaller than the artery, and piercing the capsule close to it, enters the venous plexus surrounding the convoluted uriniferous tubes, and from which the blood is ultimately conveyed out of the kidneys by the renal or emulgent vein. We have thus two distinct systems of capillary vessels, through both of which the blood passes in its course from the arteries to the veins. The first is an arterial capillary system, forming the Malpighian tufts, contained within the uriniferous tubes; the second is the venous plexus which surrounds these convoluted tubes. It has been supposed that the former serve to liberate water and the more simple elements of the blood, while the latter eliminate the more complex urea, uric acid, &c.

The *tubular substance* is internal to the cortex, and consists of fine vessels arranged in about fifteen pyramids; the bases directed outwards, the apices towards the hilum. At and near the apex these vessels are straight, but, proceeding outwards, they communicate; and, on entering the cortical substance, become twisted and convoluted in the most complicated manner.

The *papillæ*, or the *mammillary processes*, form the apices of the cones. Each is perforated by a number of fine holes, the orifices of the individual tubes, and through which the urine flows when these are compressed. The extremities of the papillæ are embraced by the *calyces*, membranous cups which unite with each other at the other end to form the ureter. Those calyces of each extremity, as well as those in the centre, unite into the three small tubes, the *infundibula*, which, after a short course, terminate in the *pelvis*, an oval flattened reservoir, which is continued into the ureter.

2. The Ureter is the excretory duct of the kidney, and extends to the urinary bladder. Each ureter is about eighteen inches long, and of the thickness of a goose-quill. They enter the bladder by passing obliquely between its muscular and mucous coats.

Attached to the upper extremity of each kidney is a small gland-like body, termed *renal capsule*, or *supra-renal* body. They are well supplied with vessels, but do not appear to be especially connected with the kidneys. Their use is unknown, although it is probable that with the thymus and thyroid bodies they are concerned most especially in the economy of the fœtus.

3. The Bladder, *vesica urinaria*, is the reservoir of the urine, which constantly trickles into it from the ureters. It lies behind the pubes, and rests

on the rectum. It possesses muscular fibres, and a cervical sphincter. The different regions have received different names, as the *superior fundus*, for the superior anterior extremity; *inferior fundus*, the posterior extremity resting on the rectum; the *body*, the intervening portion; and the *cervix*, the portion connected with the pubes, above the rectum.

4. The Urethra. The urine is discharged from the bladder by the urethra, a membranous tube, which in the male extends to the extremity of the penis; and in the female opens into the vagina, behind and below the clitoris.

The principal constituent of urine is water. When evaporated, the residuum consists principally of urea, uric and hippuric acids; substances containing a very large amount of nitrogen. Food, mode of life, &c., greatly affect the nature of the urine. The presence of lactic acid is denied by some authors. Extractive matters are present, especially during a vegetable diet, also certain mineral substances, as phosphoric and sulphuric acids, alkaline carbonates, earthy phosphates, and chlorides. The sulphuric acid combinations enter in greatest amount, and to a larger extent, under a purely animal diet, than when the food is more miscellaneous.

Urine is generally acid; occasionally, however, it is alkaline, and it always exhibits a conversion of its urea into carbonate of ammonia during putrefaction. Certain substances are readily eliminated from the blood by the kidneys; others with more difficulty or not at all. Alcohol, sulphuric ether, camphor, musk, and many vegetable colors, are not removed from the blood. On the other hand, carbonates, sulphates, chlorates, and nitrates of potassa, coloring matter of indigo, musk, castoreum, assafœtida, &c., are entirely separated. An intermediate class undergoes a transformation before elimination.

Pl. 130, *fig.* 19, exterior of a kidney: [1], supra-renal body; [2], kidney; [3], ureter; [4,5], artery and vein. *Fig.* 20, section of a kidney: [1], cortical substance; [2], a Malpighian pyramid, composed of uriniferous tubercles and the pyramids of Ferrein, with the papillæ; [3], a calyx; [4], pelvis; [5], ureter. *Fig.* 21, bladder: [1], muscular layer, with its differently arranged fibres; [1'], neck of the bladder, with its sphincter muscle; [2,3], ureters; [4], suspensory ligament from the peritonæum; [5], vesicula seminalis; [6], prostate gland; [7], portion of the urethra.

SURGERY.

By Surgery is to be understood that portion of the Healing Art which seeks to remedy such diseases and malformations of the human body as can be affected by external applications, whether they be medicines or instruments, &c.; keeping, however, in mind that internal medicines acting upon the whole system, and a proper diet, are almost always to be conjoined.

The following preliminaries to every surgical operation are carefully to be borne in mind: The system of the patient, as well as his mind, must first receive proper preparation. When possible, sufficient and skilful assistance must be at hand; the location and the position of the patient must be suitable both for the individual and the operator; all necessary apparatus, instruments, bandages, &c., must be in proper order and prepared for all emergencies; finally, the operation must be finished as quickly as possible, to relieve the patient from pain.

As it is the pain of a surgical operation that is most dreaded by the patient, due attention should be directed to alleviating this as much as possible. To this end various means may be employed; such as compression of the nerves between the part to be operated upon and the brain, which may be effected partly by the hands, and partly by means of instruments. Narcotic appliances, as opium, are also used for the same purpose. In the use of sharp instruments, they should be perfectly sharp and free from rust, and every instrument, before being used, should be heated slightly and rubbed with fresh olive oil: the application of this substance not only diminishes pain, and increases the sharpness of cutting instruments, but also facilitates the introduction of such as are blunt. Quite recently the inhalation of ether and chloroform has been used as an anæsthetic agency to the greatest advantage. To give a complete description of all surgical instruments now in use would require many volumes, as every operator has forms peculiar to himself. We shall restrict ourselves to a brief notice of such as are most generally employed, considering them under the heads of the principal varieties of operations. Instruments almost always in the hands of the operator are lancets, trochars, knives of the most varied forms, hooks, probes, sondes, forceps, nippers, scissors, saws, chisels, hammers, needles, &c. Figures of some of these are given on *pl.* 140. *Fig.* 1, usual form of thumb lancet; *fig.* 2, Spanish lancet; *fig.* 3, abscess lancet; *fig.* 4, Petit's trochar, with the canula; *fig.* 11, common tenaculum; *fig.* 13, simple button-headed sound; *fig.* 14, common forceps; *fig.* 16, straight scissors; *fig.* 17, curved scissors.

1. Blood-Letting.

Blood-letting is made use of partly to diminish the amount in the system, and partly to restore circulation and to conduct it to or from some parti-

cular region. It thus comes into play in such diseases as plethora, inflammation, congestion, cramps, fever, &c. The principal methods of extracting blood are as follows.

1. Scarification. This consists in making numerous superficial incisions in the skin of a particular spot with a lancet (*pl.* 140, *figs.* 1 and 2), or with some special apparatus, for the purpose of removing fluids from the capillaries or from the cellular tissue.

A convenient instrument for this purpose is known as the *scarificator* (*fig.* 31 *a b*), which consists of a cubical brass box in which ten to sixteen lancets turn on a common pivot so as to have their points project above the surface; the extent of their projection is regulated by a screw. On drawing back the handle, the lancets disappear beneath the surface and are there held by a spring. Bringing the scarificator over a given spot, and loosening the spring, the lancets will all fly out at once, and produce as many delicate incisions. The operation of *cupping* is usually connected with the use of this instrument, and is intended to facilitate the flow of the fluids to be extracted. The cups, consisting of little bells of glass, are laid over the spot scarified, and the included air exhausted by means of a burning piece of paper, previously introduced. The pressure of the external air causes the blood to flow freely. Sometimes the exhaustion is produced by means of a small air-pump.

2. Venesection, or Blood-Letting, is a time-honored operation, constantly brought into requisition; it consists in opening a single vein, and permitting as much blood to flow therefrom as may be desirable.

The surgical apparatus necessary in blood-letting includes a soft linen bandage of about a yard in length and two inches in breadth; a bleeding lancet (*fig.* 1), which, in the hands of a skilful operator, has great advantages over the spring lancet; a compress formed of a roll of linen about a yard long and two inches broad; proper vessels for receiving the blood; a soft sponge, and clean lukewarm water.

Bleeding with the *spring lancet* (*fig.* 32 *a b*, the common spring lancet; *fig.* 33, the lancet of Walbaum; *fig.* 34, the lancet of Perret, *a*, *b*, *c*, various blades) requires the same preparations as with the common lancet. After the vein has been prepared, the spring of the lancet is to be set, and the blade brought over the spot where the incision is to be made. On touching the spring, the blade is liberated and pierces the vein.

Pl. 139, *fig.* 1, bend of the elbow or the usual spot for blood-letting, the skin supposed to be removed: [1], trunk of the basilic vein in the depression along the inner border of the biceps brachii; [2], cephalic vein on the outer side of the biceps, and separated from the nerve by the fascia; [3], [3], basilic and cephalic veins on the forearm; [4], a probe introduced under the brachial artery; [5], median vein which communicates with the deep vein in front of the opening in the aponeurotic membrane, and divides above to unite by a short branch (median cephalic) with the cephalic vein, and by a longer branch (median basilic) with the basilic vein; [6], superficial posterior basilic vein; [7], superficial posterior cephalic vein; [8], trunk of the great internal brachial nerve on the inside of the basilic vein; [9], muscular cutaneous

nerve dividing principally about the median vein; [10], aponeurotic strip, which, proceeding from the tendon of the biceps, overlies the brachial artery and vein, and median nerve, and passes into the radial side of the fascia of the forearm; [12,12,12], circumference of the opening in the aponeurosis, well defined internally, but externally confounded with the cellular tissue; [13,13], brachial artery; [14], radial artery; [15], ulnar artery; [16], median nerve; [17,17], brachial vein; [18] and [20,20], outer muscles, and [19,19], inner muscles of the forearm; [21], internal condyle of the elbow; [22], a hook by which the opening in the fascia is drawn inwards to show, above the tendinous strip of the biceps, the brachial artery and vein, the median nerve, the brachiæus internus muscle, and the protractor teres; [23], everted skin with adipose tissue; [24], skin of the forearm; [25], skin of the arm.

In inflammation of deep-seated parts, especially such as threaten suppuration, and even when this has already commenced, powerful counter-irritants are frequently necessary and advisable; these may consist in the introduction of setons, in the use of caustics, or the still more severe application of the actual cautery with red hot iron, and of moxas. The irons used in cauterization differ much in form. We shall here only mention the prismatic cautery of Larrey (*pl.* 140, *fig.* 38), whose prism has a narrow base in proportion to its height, and has the anterior corners cut off obliquely; also the prismatic cautery of Kust (*fig.* 39), which is 1 inch 4 lines long and has three equal surfaces $\frac{3}{4}$ of an inch in breadth.

3. Acupuncture is an operation which has for a long time been successfully used in various ailments, as rheumatism, gout, &c. It consists in repeatedly piercing the part affected with a long needle, moving it backwards and forwards in the wound.

Sarlaridere's galvanic acupuncture needle (*figs.* 40, 41).

2. Sewing up of Wounds, or Sutura Cruenta.

Wounds are of various sorts: they are *punctured*, when produced by a pointed instrument; *incised*, when made by a cutting instrument; *lacerated*, when the parts are lacerated or torn; *poisoned*, when some virulent substance has been introduced; *contused*, when made by a blunt body, as a bullet. Incised and punctured wounds are of most frequent occurrence, and formerly were almost entirely treated by sewing up the edges; more modern surgery, however, rarely uses anything else than sticking-plaster and proper bandages, by which the lips of the wound are more closely approximated and the reparative powers of the system less interfered with. The following sutures are those most employed at the present day, when at all necessary.

1. The Interrupted Suture, sutura nodosa (*pl.* 140, *fig.* 28). This requires as many ligature needles as there are ligatures, the needles being of various shapes to suit the emergency (*fig.* 25, the ligature needle of Assolini; *fig.* 26, do. of Blasius; *fig.* 27, do. of Savigny). Each needle is to be provided with one or more turns of thread, as the case may require.

After the wound has been cleaned and the flow of blood has ceased, the point of the needle is to be passed through the lips of the wound previously brought into contact, and the two ends of the thread tied in a simple or a slip knot; the knot, however, should not rest directly on the edge of the wound. Each end of the thread or ligature may be provided with a needle, and the needles be introduced to the bottom of the wound and passed outwards on each side. After tying the knot, the ends of the thread may be fastened down to the skin with plaster; a similar strip should be laid between the ligatures, a roll of lint coated with cerate placed on the wound, upon this a compress, and finally a suitable bandage.

2. The Twisted Hair Pin, or Figure-of-Eight Suture (*fig.* 29), is the suture usually employed in cases of hare-lip. Straight hair-pin needles are introduced at suitable distances through both edges of the wound, and after the lips have been brought into contact, a thread is wound round the pin from one side to the other, in a figure-of-eight manner.

3. The Quill Suture (*fig.* 30) is an interrupted suture with the threads tied over rolls of adhesive plaster, or quills, which thus supply the place of the lateral compresses.

It frequently becomes necessary to employ instruments in the opening of abscesses, or collections of pus, which may exist in different parts of the body. The incision is usually made on the most protruding portion by means of a lancet (*figs.* 1—3), or a scalpel (*figs.* 7, 8); a sharp bistoury (*fig.* 9) may also be employed. Should the abscess be deep, a trochar may be required (*fig.* 4, Petit's trochar and canula). This consists of a steel rod or stylet fitting accurately into the hollow cylinder or canula, beyond whose extremity its point projects. The puncture is made with the stylet in the canula, and on removing the former, the fluid passes out through the latter.

Sometimes the pus from an abscess escapes between the soft parts of the body by a longer or shorter channel, which ultimately opens outwards, producing a *fistula*. These fistulous canals require to be opened throughout their entire length by a bistoury (*pl.* 140, *fig.* 9, sharp bistoury; *fig.* 10, blunt bistoury).

3. Aneurism.

By aneurism is meant a dilatation of an artery in some particular spot, producing a tumor, which will be likely to burst in time, unless the proper precautions are made use of. These precautions consist essentially in obstructing the flow of blood through the artery at the spot affected.

Among the instruments necessary in operations for aneurism may be mentioned the tourniquet: *figs.* 86, 87, Henkel's field tourniquet; *fig.* 88, Savigny's tourniquet; various knives, sounds, needles, compresses, ligatures of waxed silk, tenacula, forceps (as *fig.* 15), scissors, &c., together with the necessary bandages.

The apparatus necessary for TYING AN ARTERY is much like that required in operations for aneurism: a straight edged scalpel (*fig.* 5), a B·omfield tenaculum artery forceps, aneurismal needle, &c. The artery is to be elevated by a tenaculum or forceps at or near the spot where the ligature is to be applied, and this passed beneath or over the artery to be severed and tied by an assistant (*pl.* 139, *fig.* 3, *a*, the vessel held by the surgeon with the forceps, *b*, the thread, *d*, *d*, passed round, and the knot tied by the assistant).

Sometimes a vessel is tied by simply passing a thread round it, without laying it bare, the extremities of the thread being then tied tightly together. *Pl.* 139, *fig.* 2, *a*, the bleeding vessel; *b*, *c*, points where the needle is first passed in and out; *d*, *e*, points where this is done a second time.

The *method of torsion* consists in twisting the extremity of the severed vessel several times round with sliding forceps (*pl.* 140, *figs.* 35, 36, 37).

Pl. 139, *fig.* 4, is intended to show the usual points of incision either in tying wounded arteries, or in performing operations on aneurism: *a b*, incision for laying bare the superior thyroid artery, which begins near the angle of the lower jaw, over the submaxillary gland, and descends an inch and a half to the lower border of the thyroid cartilage; *c d*, incision for exposing the carotid artery. This, two and a half inches long, passes along the inner border of the sterno-cleido-mastoid; *e f*, Zang's incision for the same purpose as the last. It descends from the top of the cricoid cartilage, between the two portions of the sterno-cleido-mastoid on its outer margin, and ends one quarter of an inch above the clavicle; *g h*, Zang's incision for exposing the subclavian artery above the clavicle. It commences two inches above the clavicle, on the posterior margin of the sternal extremity of the sterno-cleido-mastoid, and passes obliquely downwards and outwards to the middle of the upper margin of the clavicle; *i k*, Hodgson's incision for the same purpose as the last, along the upper margin of the clavicle, to the point of attachment of the trapezius to the clavicle; *l m*, incision for exposing the subclavian along the inner margin of the scalenus anticus immediately over the sternal end of the clavicle, three inches long; *n o*, incision for exposing the subclavian beneath the clavicle; *q r*, Rust and Zang's incision for the same purpose; *s t*, Lisfranc's incision for exposing the axillary artery in the axilla; *u v*, incision for the brachial artery in the middle of the arm; *w x*, incision in the left arm for the same purpose, a little higher up; *y z*, incision for the same purpose in the bend of the elbow; [1, 2], incision for the radial artery along the upper portion of the forearm; [3, 4], the radial artery over the carpus; [5, 6], the ulnar artery in the superior portion of the forearm; [7, 8], ulnar artery over the carpus; [9, 10], incision for the descending artery according to Cooper; [11, 12], internal iliac after Stevens; [13, 14], do. after Abernethy and Scarpa; [15, 16], do. after Cooper; [17, 18], for exposing the crural artery below the groin; [19, 20], do. in the middle of the thigh; [21, 22], the posterior tibial artery along the upper third of the leg after Marjolin; [23, 24], do. in the middle of the leg, after Lisfranc; [29, 30], do. behind the inner ankle; [25, 26], incision for the anterior tibial in the middle of the leg; [27, 28], do. in the lower part of the leg.

Tying of the common carotid, after Zang, *pl.* 139, *fig.* 5; A, B, incision laying bare the carotid artery: [1], sternal, [2], clavicular portions of the sterno-cleido-mastoid muscle; [3], omo-hyoid muscle; [4], rectus capitis anticus major muscle; [5], portion of the thyroid gland; [6], sheath surrounding the carotid artery and internal jugular vein, a portion of it removed; [7], common carotid; [8], internal jugular.

Tying of the axillary artery in the left axilla, fig. 6 *a;* A, B, incision exposing the artery: *a*, axillary artery; *b*, external thoracic artery; *h*, external thoracic vein; *o*, musculo-cutaneous nerve; *p*, median nerve; *q*, ulnar nerve. In the region of the incision, *b b*, external thoracic artery; *c*, subscapularis artery; *d*, posterior circumflex scapular artery; *e*, anterior do.; *h*, external thoracic vein; *i*, subclavian vein; *k*, posterior, *l*, anterior circumflex scapular vein; *m*, brachial vein; *n*, ulnar vein; *r*, median cutaneous nerve of the arm.

Tying of the brachial artery in the middle of the arm, fig. 6 *b*, A, B, incision: [1], musculo-cutaneous nerve; [2], median nerve; [3], brachial artery; [4], radial nerve; [5], brachial vein.

4. Trepanning.

The penetration of the cavity of the cranium by sawing out a circular portion of its walls (trepanatio cranii) belongs to the earliest surgical operations.

The principal instrument required is the one known as the trepan or trephine, of which innumerable modifications have at different times been constructed. *The curved or brace trepan* is shown in *pl.* 140, *fig.* 62. This consists of a handle part and two extremities. The handle, *a*, is a cylindrical steel rod, about four inches long, and surrounded by ebony three quarters of an inch thick in the middle, tapering towards the ends, and attached nearly at a right angle to the two arms. The upper arm, *b*, is of steel, three and a quarter inches long, and consisting of two equal arcs; at its anterior extremity is the perpendicular steel portion, *c*, one inch long and five lines thick, thickened and blunt below, and turned off above so as to present a cylindrical pin an inch and a half long, ending with a short four-sided female screw, and when in use connected with the head, *k*. The cylindrical portion, *f*, of the head is twenty lines long, strongest superiorly, with a screw collar above of three lines in length, and pierced by a cylindrical canal which fits over the pin, *d*. The superior portion of the canal receives the disk, *g*, which, with its quadrangular hole, is placed over the female screw of the pin, *d*, and fastened by the screw, *h*, in such a manner that the cylinder cannot come off from the pin. The button, *i*, is a circular disk, two inches broad, rounded off on both sides, having in its inferior surface a screw cavity which fits over the male screw out on the upper end of *f*. The lower arm, *l*, is like the upper, and at its anterior extremity is provided with a cylindrical tube, *m*, seventeen lines long, and six broad. This, at its lower end, has a four-cornered cavity, *n*, for the reception of

the shaft of the perforator, which is held in place by the small spring, *o*, worked by an external lever, *p*.

Bichat's trepan, *fig.* 63, consists of a handle part, *b*, surmounted by a head, *a*, and to whose lower end, instead of a tube, is attached a hexagonal rod, which by means of an offset enters the four-sided pointed pyramid, *c*. In the roof of the crown is fastened an octagonal elongated nut, perforated longitudinally (with the roof) by a four-sided canal, corresponding to the pyramid, *c*. The pyramid is slipped into the nut of the crown, and this held at any position on the pyramid by means of a screw passing through the side of the nut. The crown is cylindrical, with vertical angular grooves, corresponding to the teeth cut on its cylindrical extremity.

The *hand trepan*, or trephine (*fig.* 64, crown 63 *bc*), consists of a perforator with movable central axis, handle, and screw. The handle, *a*, *a*, is of ebony, three and a half inches long. It is perforated in the centre for the reception of the shaft of the perforator. This shaft is hollow, and in it plays a pointed centre pin, the extremity of which corresponds to the centre of the circle of serrations, and which may be fixed at any point by a screw in the shaft.

The crowns of the perforator vary in shape. The *old conical crown* (*fig.* 65) is much like the next mentioned, and also provided with a centre pin, but more conical and with fewer sharp ridges on the side. The *conical ridged crown* (*fig.* 66) has the ridges equal in number and corresponding to the teeth, but diverging from each other superiorly. The *cylindrical ridged crown* (*fig.* 67) has teeth forming right angled triangles, so arranged as only to cut when turned in one direction.

A peculiarly constructed instrument called *Kittel's crank trepan* and *circular saw* is shown in *fig.* 68. The general features of the instrument will be readily understood from a simple inspection of the figure. C represents an arrangement by which the circular saw *t* can be employed. *s* is the central pin or pyramid of the perforator. B, a key for screwing this in or out.

After the hair has been removed from the wounded part of the cranium, three assistants stationed near, and the position of the patient settled, the bone is next to be laid bare. This is done by making a T or V shaped or oval incision, and reflecting the flaps.

The perforation of the cranium comes next in order. The brace trepan has here the advantage of the trephine. The centre pin or point of the pyramid is made to project slightly beyond the cutting plane of the crown, and is fixed by the screw. The operation is now to be commenced, and continued only until the teeth of the crown have made a well defined groove, when the centre pin is to be withdrawn or pushed up. The operation is then continued cautiously, care being taken to examine the groove frequently with a probe to ascertain whether it has reached the dura mater. To prevent splintering of the inner table of the cranium, the groove after penetrating the cranium may be smoothed off with a knife having a knob or button at the point (as shown in *fig.* 10).

5. Operations on the Eye.

Few parts of the body are exposed to such manifold evils as the eye. Great progress has been made by modern surgery in the treatment of this organ, and if in some cases its aid be ineffectual, in others every desirable result has been accomplished.

1. Affections of the Lachrymal Apparatus. A defective condition of the puncta lachrymalia and lachrymal canals and nasal duct is shown by a constant overflow of tears. Various operations have been made use of to restore the flow of the lachrymal secretion through these natural channels. Anel invented a syringe (*pl.* 140, *fig.* 50) the fine point of which is introduced into the puncta, and an injection of lukewarm water forced through. This syringe (from ¼ to 1 oz. capacity) is made either of silver or of glass; the exceedingly fine tubes, of gold, silver, or steel. *Fig.* 54 represents a peculiar jet piece as used by Laforest.

Operations frequently become necessary for obstruction of the nasal duct, caused by accumulation of matter, contraction of the parietes, or even by the entire absence of the bony canal. In fistula lachrymalis it becomes necessary to open the lachrymal sac for the purpose of restoring the function of the duct. For this purpose is used a small scalpel (Rutdorfer's fistula scalpel), the point of which is introduced deep enough into the part affected to overcome any slight resistance (*pl.* 139, *fig.* 8 *a*); the incision is then to be widened, and the fistula opened, if present. A blunt probe is next to be pushed into the nasal duct (*fig.* 8 *b*, and *pl.* 140, *fig.* 53); should this meet with any obstruction, so as absolutely to bar its passage, a sharp probe is to be employed to pierce through this obstruction, and so to open the duct.

The restoration of the nasal duct is much preferable to the formation of an artificial one; cases do occur, however, where the latter is alone possible. After the lachrymal sac is opened, a trochar (*fig.* 56, Bell's trochar) is introduced through the lachrymal bone, and turned round until it penetrates the nasal cavity. After inflammation has subsided, a style of silver or a piece of catgut bougie may be introduced into the aperture.

Pl. 139, *fig.* 7, after Scarpa, illustrates the position of the lachrymal sac.

Among diseases of the eyelids requiring an operation, we find *entropion* or permanent inversion of the eyelids, and with it the turning in of the eyelashes. By means of an anatomical forceps, or an entropial forceps (*pl.* 140, *fig.* 48), a fold of the skin of the eyelids is taken up sufficiently large to bring the edge of the lid and the cilia in their normal position; this fold is then to be cut off with a pair of scissors, and the edges brought together. The inversion will usually be counteracted by the resulting cicatrix.

It sometimes becomes necessary to cut off the whole eyelid with the roots of the cilia. A thin plate of bone or silver is introduced beneath the eyelid, and the border then cut off. The knife used by Jüngken in this operation is represented in *fig.* 47.

2. Of Cataract. By this is understood an opacity of the crystalline

lens or its capsule by which vision is obstructed either totally or partially. When the lens alone is affected, the cataract is *lenticular;* when the capsule alone, *capsular;* and *capsulo-lenticular* when both are concerned.

In operating for cataract, the lower eyelid is to be drawn downwards and outwards by the index and middle finger of the left hand of the operator, while an assistant supports the chin with his left hand and holds back the upper eyelid with his right.

All the different operations for cataract have as their object the displacement of the lens and capsule. This is effected either by removal through the cornea or sclerotic, by pushing to one side, or by cutting into pieces so as to cause the absorption of the fragments.

a. Extraction. This operation involves three stages: 1, the opening of the eyeball by means of semilunar incisions in the cornea; 2, the opening of the capsule; and 3, the removal of the lens through the pupil. The incision is made with the cornea knife, the form of which varies greatly (*pl.* 140, *fig.* 59, Beer's knife; *fig.* 57, Bell's knife; *fig.* 58, Sharp's knife). The right eye must be operated with the left hand, the left with the right (*pl.* 139, *fig.* 10, operator with Beer's knife; *fig.* 11, do. with the double knife of Jäger). Jäger's knife is asserted to have the advantage of causing a wound which heals sooner, and without as much probability of the protrusion of the iris and vitreous humor. A modification of Jäger's knife (*pl.* 140, *fig.* 61) has been proposed by Ott. After the incision has been made through a little more than one half of the circumference of the cornea almost close to the sclerotic, the upper eyelid is to be dropped for a few seconds, and then carefully raised for the introduction of the instrument intended to open the capsule. This is best effected by the lancet-shaped cataract needle. Instruments called cystitomes (*fig.* 60, La Faye's as improved by Richter) have been recommended by some, but they are liable to serious objections. Three or four vertical and several transverse scratches of the capsule are now made with the cataract needle. The lens will then usually come out of the capsule, but may require the assistance of a gentle pressure. Various attempts have been made to extract the capsule with the lens, and for this purpose different forceps have been invented, such as Beer's forceps, (*fig.* 44), Graefe's do. (*fig.* 45), Maunoir's do. (*fig.* 46). The experiment of making the entrance through the sclerotic has been attended with considerable difficulties and dangers, so that the present method is most generally employed, excepting where the next mentioned is preferred.

b. Keratonyxis consists in the introduction of a needle through the cornea for the purpose of breaking up the cataract, separating it from its connexions, in order that it may be dissolved and absorbed; or else to depress it and thus force it out of the axis of vision. The latter operation is more correctly termed couching.

Both curved and straight needles may be used in these operations; the former, however, are preferred. The operator pierces the lower part of the cornea, far enough from its border to clear the pupillary margin of the iris (*pl.* 139, *fig.* 12).

Bowen has proposed a mode of operating which he calls *hyalonyxis* (*fig.* 13); a curved needle, with the convexity anterior, is so introduced, about three or three and a half lines from the margin of the cornea, and one line beneath the transverse diameter, as to enter the vitreous humor behind the lens and capsule; the posterior wall of the capsule is torn, the lens depressed in the vitreous humor, and the anterior wall of the capsule then torn in a similar manner.

3. Contraction and Obliteration of the Pupil (Syninesis, Obturatio, Imperforatio, Phthisis pupillæ, Atresia iridis). There are three methods by means of which an artificial pupil can be obtained: 1. By cutting the fibres of the iris (*coretomia* or *iridotomia*); 2. By cutting out a segment of the iris (*corectomia*, *iridectomia*); 3. By destroying the connexion between iris and ciliary ligament (*coredialysis*, *iridodialysis*). Sometimes two methods are combined, for the sake of greater certainty.

In iridotomy and iridectomy, an incision is first made in the cornea, through which the operator introduces a pair of very delicate scissors (*pl.* 140, *figs.* 42, 43), which may be either straight or curved; these are to be opened, and one point to be inserted into the iris, and a section made running towards the transverse diameter. A second section is so made as to include a V-shaped piece between the two (*pl.* 139, *fig.* 14). Owing to the not unfrequent junction of the iris at the edges of the insections, the second mode of operation was resorted to, that of iridectomy, in which a pupil was formed by cutting out a portion of the iris. This is conducted in a manner similar to the last processes; the piece there formed is taken up by fine forceps (*pl.* 140, *figs.* 44, 45, 46), and cut off with fine scissors. The hook-forceps (*fig.* 44) have been used to advantage in these and similar operations, to insure a firm hold of the object to be grasped.

6. Hare-Lip.

Hare-lip is a congenital malformation of the lip, an arrest in the development of it while the remaining portions of the system have advanced to proper perfection. It generally occurs alone, but frequently is found associated with a fissure of the palate.

The first part of the operation consists in paring the edges of the lip, either with scissors or with the scalpel.

In operating with the scissors (*pl.* 139, *fig.* 17), the lower corner of the fissure is grasped with the hand or a hook, the lip drawn downwards and outwards, the blunt edge of a tolerably strong pair of scissors is introduced between the jaw and the lip, and the borders of the incision are taken off at a single cut. The bent scissors represented in *pl.* 140, *fig.* 18, are most convenient for this purpose. After the cuts have been made on each side of the fissure, the second stage of the operation is to be carried out, consisting in the approximation of the wounded edges, which are retained by needles, but sometimes by adhesive plaster.

The bloody suture (sutura cruenta) is effected in various ways. The

figure-of-eight suture is the one most usually employed, and for this reason frequently called hare-lip suture. The shape and size of the needles vary greatly. Dieffenbach made use of fine insect needles or pins, which, after being properly wrapped, are cut off close to the thread. Two needles usually suffice for children, three for adults. *Pl.* 139, *fig.* 18, *a b c*, shows the mode of introducing the needles. As soon as a needle is inserted, it is wrapped with thread and fastened, and a common thread may finally be wound over all the needles (*fig.* 19). Should the lip be much drawn up or shortened, circular incisions may be made on each side, as shown in *fig.* 20, *a b*.

7. Cleft Palate.

A fissure of the palate is frequently found associated with hare-lip: it may be a congenital disease, or the result of injuries or diseases of after-life. Like hare-lip, too, it is an arrest of development which prevents the corresponding lateral portion of the palate from uniting along the median line to form a continuous roof to the mouth.

Formerly it was the custom in such cases to supply an artificial roof to the mouth by means of a plate of gold, silver, horn, &c. This answered more or less satisfactorily for fissures of the hard or bony palate, while fissures of the soft palate were, until quite recently, considered irremediable and incurable. The operation of suture of the palate, better known as *staphyloraphia*, was first attempted by Græfe in 1816. This consisted in paring off the edges of the fissure, which were afterwards brought into such approximation that the sides united perfectly. Experience, too, has shown that the operation not only obliterates the fissure in the soft palate, but ultimately that in the hard palate likewise.

A piece of cork is required to be placed between the back teeth, for the purpose of keeping the mouth open during the operation. Different kinds of knives have been made use of to pare the edge of the fissure, as also various forceps and tenacula for arranging the edges. Ligatures of about two feet in length are necessary. Various forms of needles, needle-holders, and forceps are required for making the attachment, and special instruments are required for tying the knots.

The operation is conducted as follows: The mouth of the patient is opened, and the base of the tongue depressed. With a knife, having a blade somewhat like the edge of a lancet, the cutting edge about a quarter of an inch in extent, and the flat surface bent semicircularly, an incision is made about half an inch long on each side of the posterior nares, a little above and parallel to the palatine flaps, and across a line straight downwards from the lower opening of the Eustachian tube, by which the levator palati is divided on both sides, just above its attachment to the palate. The edges of the fissure are next pared with a straight blunt-pointed bistoury, removing little more than the mucous membrane; then, with a pair of long, blunt-pointed, curved scissors, the posterior pillars of the fauces are divided

just behind the tonsil, and, if necessary, the anterior pillar likewise; the wound in each part being about a quarter of an inch in extent. Lastly, stitches are introduced by means of a curved needle set in a handle, and the threads tied, so as to keep the edges accurately in contact (*pl.* 139, *fig.* 31).

8. Odontalgia.

Diseases of the teeth are so numerous and important, that their treatment constitutes a separate branch of surgery. We shall here only refer briefly to the principal instruments used in the extraction of teeth, usually the only method by which odontalgia, or tooth-ache, can be effectually cured. In the multiplicity of contrivances for extracting teeth under all possible circumstances, we can find room for comparatively few.

The first step in the extraction of teeth consists in cutting the gum around the neck of the one affected. Convenient instruments for this purpose are those invented by Cruce (*pl.* 140, *figs.* 69, 70). They consist of two handles with sharp bent extremities. Pare's apparatus (*fig.* 71) is a steel rod, fastened into a handle, and with a spatulate bent end.

For the extraction, we have first the *parrot-beaked forceps* (*fig.* 72), with a spring between the handles to keep them apart. *Fig.* 73 represents the large curved forceps for extracting canine and anterior molar teeth. Mortet's forceps (*figs.* 74, 75).

Pl. 139, *fig.* 28, illustrates the mode of extracting a lower incisor by means of the forceps.

The simple key (*pl.* 140, *fig.* 76 *a b*) consists of a steel stem, four and a half inches long, with a wooden or bone handle. Into an incision in the bent upper end, the hook, *b*, is inserted and retained by a screw.

The key with movable hooks (*fig.* 77) is much like the preceding, except in having an offset, *a*, which receives the hook, *b*, and is held by a screw.

Pl. 139, *fig.* 29, exhibits the method of extracting a back tooth by means of a key. The stem of the instrument is usually wrapped with a handkerchief, to prevent contusion of the gums.

9. Restoration of Lost Parts.

(*Chirurgia curtorum, Transplantatio, Merioplastice.*)

This art has been known for a long period of time. It depends upon the highly interesting physiological phenomenon, that parts of the body may be separated and transferred to another part, or even to an entirely different individual, and yet form a vital and persistent attachment. It is in cases of deficiency or malformation of parts of the face, that this art has been made use of with greatest success, and especially in the formation of a new nose, known as the Taliacotian or rhinoplastic operation.

Restoration of the nose by means of a flap from the forehead. In the first place, a model corresponding to the face and stump of the nose is to

be constructed of wax or clay; this measured with strips of paper, and the outlines thus obtained marked off on paper and cut out. This outline is then to be spread out flat on the forehead, the base uppermost, the apex at the top of the nose, and marked out on the forehead with ink. Dots of ink should also indicate where the sutures are to be made, four on each side being usually sufficient. The operation itself presents four stages. In the first, the margin of the outline on the forehead is to be cut through, excepting the narrow neck between the eyes, and the flap of skin dissected from the periosteum. When the bleeding has ceased, the flap is to be twisted on itself, and its edges fitted into the grooves made for its reception, and these fastened with sutures. A roll of oiled lint is then to be introduced into each nostril, for the purpose of supporting the nose, and a pledget above the septum; the wound on the forehead filled with dry lint; and the ligatures removed after from forty-eight to seventy-two hours. After adhesion has thoroughly taken place, the twisted strip of skin by which the connexion with the forehead was maintained, is to be cut through, or a little strip cut out, so that it may be laid down smoothly. (*Pl.* 139, *fig.* 21.)

This mode of operating has experienced various modifications by different surgeons. *Pl.* 139, *fig.* 24, represents the method adopted by Delpech in a particular case; *fig.* 25 is the flap of skin brought down and then twisted.

Fig. 22 exhibits a newly formed nose, after Dieffenbach, in which all the hard parts had been lost, and the soft parts either destroyed by suppuration, or fallen in. The soft parts were first trimmed off even, and dissected out to a slight amount beneath the skin of the cheeks, and a transverse incision made in the upper lip to receive the septum; after this the flap was brought down from the forehead and attached as before described. Some surgeons prefer to form the septum of the nose by a subsequent operation from the upper lip.

When the nose is to be formed out of the skin of the arm, a model of it is to be made, and the surface of the model cut out in paper and marked off on the arm. Græfe has invented a special apparatus for connecting the arm and face, consisting of a cap, jacket, and arm bandage, shown in *pl.* 139, *fig.* 26. The cap, *a*, is prolonged on each side in a flap, *c*, by means of which it is fastened under the chin. Above is sewed to it the bandage, *d*, for holding the wrist. Opposite threads are attached to the cap, which are tied together to hold the bandages, *p*, *q*, *r*; two are at *g*, two at *c*, and two on the other side of the head opposite to *g*. A small ring is fastened at *f* with strong tape, and through it passed a bandage, by which the entire head may be drawn back towards *k*, if necessary. The cap is attached to the jacket, *b*, at *u*. A second ring is placed at *i*, for the purpose, by means of a tape, of drawing the arm towards the left, if required; another is situated on the right side. The pantaloons are fastened to the waistband, *h*. The arm bandage consists of the linen band, *l*, *m*, *n*, *o*, with six side bands; the former consists of a part for the upper arm, *s*, *n*, and the forearm, *s*, *l*. The arm portion is attached along the border, *m*, *o*, to the three side bands, *p*, *q*, *r*, by nine narrow tapes or silk strings; the same arrangement exists on the

opposite side. The position of the side bands is secured by the six strings attached to the cap.

Fig. 27 represents the flap of skin dissected from the arm and attached to it only by its base. It is cicatrized along its margin and under surface, and thereby prepared for attachment to the stump of the nose.

10. Extirpation of portions of the Tongue.

For this operation will be needed a piece of cork, and a polypus forceps, or Muzeux' tenaculum forceps (*pl.* 140, *fig.* 12). It will sometimes be necessary to pass a string or loop through the sound part of the tongue, for the purpose of drawing it out during the operation, and for stopping the flow of blood. There will also be required a straight, a sharp, and a blunt bistoury, a Cooper's scissors, ligature apparatus, cautery irons, cold water, ice, &c. The tongue of the patient is to be protruded as far as possible, and held by forceps or a loop. The operation itself is conducted either by means of an incision or by ligature.

Pl. 139, *fig.* 30: at the points *g* and *h*, two needles are passed through from beneath, each provided with a separate and a common thread, the latter of which, *g*, *k*, *h*, *i*, is tied on the back of the tongue; the two former, *g*, *l*, *m*, and *h*, *n*, *o*, are fastened in the edges. For removing the small portion of the side of the tongue, a needle with a double thread is passed through at *p*, and the two ends of those tied together at *q* and *r*.

11. Œsophagotomy.

This is resorted to sometimes for the removal of foreign bodies, partly for the purpose of introducing food.

For the first end, three methods have been proposed, that of Eckholdt with the most favor. The operation is to be performed in the triangular space included between the two crura of the sterno-cleido-mastoid and the clavicle. The skin is in an obliquely transverse fold, and an incision made of about two inches in length, running downwards and inwards to the sternal end of the clavicle, and the platysma separated. Should the space between the muscular portion be too much confined to permit a sight of the laryngeal nerve lying along the œsophagus, the angle of the two heads is opened up on a director by introducing this close behind the muscle, and thus avoiding any danger of injuring the inferior thyroid artery and the omo-hyoid muscle. The omo-hyoid may be then pushed up, the carotid artery and jugular vein outwards, the œsophagus laid bare, and then opened either against the foreign body or a small aperture made and enlarged with forceps, or by the introduction of a director.

Pl. 139, *fig.* 32, the lips of the incision are separated by means of two double tenacula: [1], sternal, [2], clavicular portion of the sterno-cleido-mastoid muscle; [3], sterno-thyroid muscle; [4], omo-hyroid do.; [5], thyroid gland;

[6], trachea; [7], carotid artery; [8], inferior thyroid artery; [9], laryngeal nerve and branches; [10], cellular tissue.

To extract the foreign body after the operation, we may make use of a straight forceps (*pl.* 140, *fig.* 15), or if it be some distance from the opening, of a curved forceps as shown in *fig.* 78. Degenerate portions of the membrane of the œsophagus, false membranes, &c., may be removed with the knife or with the scissors. The introduction of nourishment when necessary is to be effected by means of a flexible tube.

If the foreign body be not too large it may in most instances be removed without an operation. An instrument for extracting such substances, invented by Petit, and improved by Eckholdt, is shown in *fig.* 79. It consists of a handle, *a;* a ferule, *b;* a whalebone rod, *c c;* a silver tube with two hooks, *d*, to which is fastened an elastic tube, *e e*; *f* is a long cylindrical piece of sponge to which are attached some loops of thread, *g*, to catch hold of small angular bodies.

For the extraction of bodies of moderate size Eckholdt made use of the apparatus shown in *fig.* 80. An elastic catheter, *g g*, is provided at its superior extremity with an open convex silver ferule attached to it by two arms. Into the catheter is passed a round whalebone rod with a wooden handle, which carries a silver ferule, *b*. This ferule, *c*, has a ridge, *c*, round its margin, cut through in two opposite places; a silver tube, *e*, on the catheter has a small hook, *f*, on each side, which passing through the breaks in the ridge, *e*, and slightly rotated, serves to unite the catheter to the handle. The whalebone rod projects about two inches beyond the tube, and to its anterior end is fastened a small silver button having eight grooves radiating from the centre, cut on its surface. In these are laid four thin whalebone rods about five inches long, and crossing each other in the centre of the button; these are held in place by a small cap with eight teeth, which bend down between the rods and thus keep them in place; they are then bent over and tied along the anterior end of the tube, and afterwards surrounded by a ferule with the anterior margin bent in between the rods to keep them at a proper distance apart. The cage thus formed will of course be enlarged and expanded on drawing back the rod, and on the other hand elongated and greatly diminished in diameter by pushing the rod out or forwards. To extract pins or other sharp bodies, the cage may be covered with a small bag of fine silk, and also encircled by numerous loops of thread.

12. Amputation.

Amputation proper has reference to the cutting through of a limb: when the separation takes place at a joint, we have excision, or ex-articulation.

Amputating apparatus consists of the following instruments: two tourniquets (*pl.* 140, *figs.* 86–88, those of Henkel and Savigny); amputating knives of various sizes, single edged for circular sections, and double edged for flap operations (*fig.* 84, Savigny's knife; *fig.* 85, Weiss's knife for cir-

cular incision); a straight or bellied bistoury; knives for separating bone and cutting periosteum; amputating saws (*fig.* 21, Pott's saw); bone nippers for extracting spicula (*fig.* 20); bone scissors (*fig.* 19) and rasps; a chisel (*figs.* 22, 23); forceps (*figs.* 35, 36); artery tenaculum (*fig.* 37, Bell's); and the necessary bandages. Good assistants, generally five in number, will be required. The suggestion of Moore, to diminish the pain of an operation by compressing the principal nerves (*fig.* 89, nerve compressor), has not been much fol'owed.

Various tables have been constructed for the suitable arrangement of the patient (*fig.* 90, Kluge's table), but these are only applicable in hospitals.

The principal modes of amputation, subject, however, to numerous modifications for the different regions, are two in number.

1. *The Circular Method.* This may be either simple or double. In the simple incision, all the soft parts are cut to the bone, then pushed up, and the bone sawed off close to the muscle. Subsequently it was considered preferable to cut first through the skin, then pushing this up to cut through the muscle, and finally to separate the bone as before.

2. *Flap Operation.* The flesh is grasped by the surgeon, and lifted from the bone; the double edged knife is passed horizontally through it, the point carried over the bone, and pushed through the other side of the limb; it is then made to cut its way out upwards and forwards, so as to make the anterior flap. The knife is again entered on the inner side a little below the top of the incision, passed behind the bone, brought out at the wound on the outside, and directed so as to make a posterior flap. Both flaps are now drawn back, the knife swept around the bone to divide any remaining muscular fibres, and the bone sawed through.

Pl. 139, *fig.* 33, amputation of the thigh: *a*, *b*, hands of the first assistant; *c*, *d*, do. of second assistant; *e*, *f*, operator.

The following figures are intended to illustrate the respective positions of the individual parts after an amputation.

Pl. 139, *fig.* 34, circular amputation of the upper arm, three and a half inches above the middle: *a*, humerus; *b*, *c*, deltoid muscle; *d*, long, *e*, short head of the biceps brachii; *f*, latissimus dorsi muscle; *g*, *h*, *i*, *k*, *l*, triceps brachii; *m*, *n*, *o*, *p*, subcutaneous adipose and cellular tissue: [1], brachial artery; [2], posterior circumflex artery; [3], basilic vein; [4,5], deep seated brachial vein; [6], cephalic vein; [7], median nerve; [8], ulnar nerve; [9], middle cutaneous nerve. *Fig.* 35, circular amputation of the thigh two inches below Poupart's ligament: *a*, femur; *b*, rectus femoris; *c*, sartorius; *d*, vastus externus and tensor vaginæ femoris; *e*, vastus internus; *f*, adductor longus; *g*, gracilis; *h*, *i*, *k*, *l*, adductor magnus, adductor brevis, and semi-membranosus muscles; *m*, biceps cruræus; *n*, semi-tendinosus; *o*, adipose and cellular tissue between the adductors and gracilis; *p*, *q*, *r*, *t*, subcutaneous adipose and cellular tissue; *s*, intermuscular tissue; [1], cruræal artery; [2], deep do.; [3], external circumflex artery; [4], cruræal vein; [5,6,7], deep seated veins; [8], saphena major vein; [9–22], small and large muscular and cutaneous arterial branches; [23–25], branches of the cruræal nerve.

13. Fractures.

These occur in all the individual bones, although more rarely in some than in others.

In treating fractures, a point especially to be attended to is the transportation of the patient, especially if the distance be considerable. In the treatment proper, the first step consists in properly approximating the fractured extremities, and then in keeping them undisturbed in close contact; the rest must be left mainly to the recuperative energies of the system. *Pl.* 140, *fig.* 91, represents a bed well adapted for the ease and immobility of the patient while under treatment for the union of a broken limb.

14. Calculus.

Calculus, or stone in the bladder, is a very painful disease of frequent occurrence. Owing to the danger of a direct operation for this disease, efforts have frequently been made to discover methods by means of which such operation might be avoided. The great objection to these methods, known under the general name of *lithontripsy*, is, that they do not act directly upon the calculus, and that their long continued use, which is usually necessary, introduces a train of new evils.

We cannot pretend to enter into even a brief account of the various methods of performing operations of *lithotomy*, or extracting the calculus directly, as this would of itself require a volume. We must confine ourselves to a reference to some forms of apparatus, by which the stone may frequently be broken up in the bladder and evacuated in minute fragments. The instrument invented by Civiale, and called *lithotriptor*, has been made use of with considerable success, although liable to the danger of lacerating the coats of the bladder, and of bruising the parts about the neck. It is represented in *pl.* 140, *figs.* 81—83, and consists essentially of a straight cylindrical canula introduced into the bladder, and containing three or four branches which can be protruded by external machinery. These are then made to grasp the stone and hold it tightly, whilst it is bored, scooped, and excavated by drills contained in the centre and worked by a bow. When the stone is sufficiently excavated, its shell is crushed into small pieces.

The instrument most used at the present day is the *screw lithotrite*, composed of two sliding blades, between which the stone is seized and crushed by gradual pressure with a screw.

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